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## PREFACE

This document was produced with assistance from the following individuals:

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## INTRODUCTION

In 1979, the First General Aviation Safety Workshop was held at the Ohio State University, and was sponsored by the General Aviation Manufacturers Association (GAMA) and the Aircraft Owners and Pilots Association (AOPA). This workshop was conducted for the purpose of improving the safety record of general aviation. As a result of this event, recommendations were made by the participants regarding the initiation of certain projects which addressed current safety issues in general aviation. During the intervening 2 years, several of these recommendations were acted upon.

On January 27-29, 1981, the Federal Aviation Administration (FAA) Technical Center and the AOPA jointly sponsored the Second General Aviation Safety Workshop. This event was conducted at the Technical Center at Atlantic City Airport, New Jersey.

The purpose of the Second General Aviation Safety Workshop was to report on progress made since the one held 2 years ago, and to continue this process by developing additional recommendations. This workshop was attended by representatives of the various airframe, avionics, and engine manufacturers; aviation associations; educational institutions; insurance companies; the National Weather Service; the FAA; the National Aeronautics and Space Administration; and the National Transportation Safety Board (NTSB).

The first session of this workshop consisted of invited papers which detailed the results of recent efforts in response to some of the recommendations made 2 years ago.

The workshop participants were assigned to one of six working groups: Aviation Safety Economics, Flight Instruction, Pilot Written Exams, Weather-Related Accidents, Aviation Safety Data, and General Aviation Aircraft. In order to provide a starting point for discussions in each working group, the following initial considerations were established:

### 1. Aviation Safety Economics

a. What analytic techniques or procedures are available for use in determining the optimum use of economic resources to improve general aviation safety?

b. To what extent are available resources spent on general aviation safety programs correlated with accident causes?

c. What, if any, system inadequacies exist which prevent the prompt identification of operational problems or the implementation of research programs?

### 2. Flight Instruction

a. How could the Biennial Flight Review be changed/modified to make it more effective?

b. Should flight instructor revalidation require an in-flight demonstration of flying/teaching skills?

c. To what extent should psychological information on student pilots be used in developing optimal programs of instruction?

d. What new instructional techniques or procedures can be developed to accommodate the increasing sophistication of general aviation aircraft?

e. Are the present entry level requirements adequate for pilot certificates and ratings?

### 3. Pilot Written Exams

a. How should written exams be used to improve pilot knowledge?

b. In addition to testing pilot applicants' aeronautical knowledge, can written exams be used to assess their decisionmaking capabilities?

c. To what extent can the results of written exams be used to improve general aviation training and safety?

### 4. Weather-Related Accidents

a. How should the present system of weather information dissemination be improved to reduce weather-related accidents? (For example, Flight Service Station modernization, Voice Response System, Home-Video, etc.)

b. Should there be more than one type of instrument rating? If so, what privileges and limitations should be established for each rating?

c. What additional instrument training should be required for Private Pilot certification?

### 5. Aviation Safety Data

a. Should all aircraft accidents be investigated?

b. What are the limitations, if any, of present general aviation "exposure" data? Have present data been adequately verified?

c. What existing data now being collected are not needed?

d. What benefits are possible as a result of obtaining psychological profiles of general aviation pilots?

e. What developments have been undertaken to improve the accident/incident data bases with respect to human factors information?

### 6. General Aviation Aircraft

a. Federal Aviation Regulations (FAR) 23 requirements for aircraft design lead to varying degrees of interpretation (or misinterpretation) by industry and the FAA; are there any specific key requirements which should be changed? (Identify, list in priority, and recommend necessary words.)

b. What potential problems may exist in the certification and operation of aircraft digital flight control and avionics systems?

c. New technology is providing aircraft/systems designers the opportunity to augment or supplement aircraft handling qualities. What criteria can be provided which will delineate the degree of allocation assigned to the aircraft, systems, and crew?

d. By what means can the annual number of aircraft accidents which may be attributed to design-induced errors be reduced? (Modification, design, regulations, training, etc.) Explain and describe.

The second session consisted of reports by the chairmen of each working group on the findings of each group. These proceedings are edited transcripts of the two sessions.

FIRST PLENARY SESSION — January 27, 1981

MR. LAWTON: Good afternoon. I am Russ Lawton from AOPA and I'd like to welcome you to the Second General Aviation Safety Workshop. We have some interesting papers to be presented this afternoon, but before we get underway, I'd like to have Joseph M. Del Balzo, the Director of the Technical Center welcome you.

JOSEPH M. DEL BALZO, DIRECTOR, FAA TECHNICAL CENTER, ATLANTIC CITY AIRPORT, NEW JERSEY: Let me start by welcoming you to the FAA's Technical Center. We are proud of our new facility which was dedicated in May 1980. It's one of a kind and I hope many of you will take the opportunity to tour through it on Friday, get familiar with what the facility is, but more important, get a familiarity and better understanding of what it is that we do here. Anyone can have a facility, it's important to be judged on what you do with what you have and I think there is some pretty good work going on here. Not just in the general aviation field, but across the board. We are doing some exciting things in aircraft safety. You will begin to see the results of the work that's going on in aircraft safety implemented in the latter part of this year. It has taken us a long time to get ready to establish this capability. But I think that what you will see in the next few years will be a tremendous amount of progress in the field of aviation safety research and development.

The general aviation story, as you all know, has been one of growth in the past several years and that growth is likely to continue at a high level during the next decade. I think we all understand the reasons for that. My contribution today is to let you know that the Technical Center has a responsibility to support the growth of general aviation, and we have taken it upon ourselves to act as the spokesmen within FAA for that growth. I think that all of us agree that we would like to see the continued downward trend of the general aviation accident rate, as recently reported by NTSB, and that is why we have asked you here today. That's why we have decided to be co-host of this General Aviation Safety Workshop.

The fact that the workshop is being jointly sponsored by AOPA, in cooperation with GAMA, is the reason we have persons such as yourselves here with us today representing every segment of general aviation. I think that's a good testimony to the fact that we are serious. Like the first workshop held 2 years ago at Ohio State University, we structured this one to maximize the active participation of all of you. If we are going to be successful, it is important that all participate and give us the benefit of your thoughts and experience.

This workshop will be a failure if we don't follow through on the recommendations and the concerns that surface in each of the individual working groups. If we are to be successful at all, we need to be viewed in the light of what we do with each of the recommendations that you present to us, and I can promise you that we will take them seriously. And with that, let me close with two things. One a challenge and the other a promise. The challenge to you workshop participants is to identify problem areas and programs which if carried out will result in significant safety benefits to the entire general aviation community. I am speaking about the manufacturers, the owners, and the operators in all segments, and I would ask that each working group take it upon themselves to identify two or three of the most important problems that need attention, and recommend a program that addresses each one. And my promise in response to that challenge is that the Technical Center will be responsive to those needs and concerns and will certainly consider each recommendation. As we develop our future research programs, I would like

nothing better than to come before you 2 years from today and say, "This is what we have done in the light of what you asked us to do 2 years ago." And then I would say judge us on what we have done.

We are serious about general aviation and, as the spokesman within FAA for the growth of general aviation, I think we can do quite well. I look forward to listening to the recommendations that surface from the plenary session on Thursday, and to meeting each of you or as many of you as I can at the dinner at the Lafayette Motor Inn on Wednesday night. I thank you very much. Have a good week.

MR. LAWTON: At this time, I would like to introduce to you each of the group chairmen so that you can identify them and begin working with them tomorrow morning at 9 o'clock. If you are in the Pilot Written Examinations working group, your group chairman will be Mr. Russell Watson, manager of the Air Age Education Department at Cessna Aircraft Company. If you are in the Flight Instruction working group, your chairman will be Dr. Richard Gilson, Chairman of the Department of Aviation at Ohio State University. If you are in the Aviation Safety Data working group, you will be under the able chairmanship of Mr. Jack Enders, President of the Flight Safety Foundation. The Weather Related Accidents working group will be led by Dennis Wright, Director of the Air Space Technology Department, AOPA. The General Aviation Aircraft working group will be chaired by John Reed, who is the Acting Program Manager of the General Aviation Aircraft program here at the Technical Center. The original group chairman of the Aviation Safety Economics Group, was scheduled to be Dr. Aaron Gellman from Gellman Research Associates. We received a call from him yesterday that he must be in court to give a deposition. You will have as your group chairman Dr. Frank Berardino, Vice President of Gellman Research Associates.

Now, to get to the invited papers. I'd like to introduce Dr. Jerry Berlin. Jerry is the Director of the Aviation Research Center at Embry-Riddle Aeronautical University.

DR. JEROME I. BERLIN, DIRECTOR, AVIATION RESEARCH CENTER, EMBRY-RIDDLE AERONAUTICAL UNIVERSITY: It is indeed a pleasure to be chairing this session. In addition to the important work of the research reports you will hear presented, I feel that they are representative of new attitudes and new commitments towards general aviation on the part of the FAA, universities and aviation organizations, and, of course, on the part of the individual investigators.

First, however, I'd like to pay homage to those wonderful people who for years have been doing as much research in general aviation as they could with very little support from anyone. When I sent out the call for papers, some very interesting and relevant abstracts were returned from very unexpected sources. You will hear several of those today. It is very encouraging to know that a body of knowledge is being created for general aviation that originates from research in general aviation. As many of you know, in dealing with general aviation problems, we have had no choice but to extrapolate from findings in the area of military or transport aviation. This has always been difficult and I feel sometimes perhaps dangerous. There is certainly no question but that it has impeded the development of improved regulations, methods of training, and more effective and safer equipment. This new equipment has already significantly increased the rate at which we are gathering a body of knowledge specifically concerned with general aviation. But the most gratifying phenomenon is that this research movement is taking place in what I feel is a sensible and orderly way.

Two years ago, the AOPA and GAMA sponsored the first general aviation safety workshop. I have heard many times from many of you that the mix of attendees was good and the tone was indeed serious. One of the products of this workshop was a set of research priorities which has served as a guide to the FAA in the allocation of their resources. To preserve the systematic approach to general aviation research, this meeting was conceived to hear about what has begun and to develop new concepts as well as new priorities.

And the third workshop to be held in 1983, hopefully will do the same thing. This whole approach seems so much more responsible than a shotgun one, and I'd like to say that the originators of it deserve our appreciation. Now, before we begin, may I suggest that we hold our questions and comments, which we do indeed want, until all the speakers have had their chance and then hopefully there will be some time for us to contribute.

Our first presentation is by Dr. George Bennett. He and his co-workers at the Raspet Flight Research Laboratory located at Mississippi State University have been engaged in an extensive study of active stall deterrent systems. They have brought at least one concept to the point of readiness for certification. I have heard that other concepts even more effective are still in the development stages. It's a pleasure to have George Bennett with us.

DR. GEORGE BENNETT, MISSISSIPPI STATE UNIVERSITY: Jerry presented me with quite a problem. How do you summarize 5 years of work in 10 minutes? So bear with me that on this very short presentation I will only hit the high spots. There is an AIAA paper available on this subject and we will be glad to send you copies.

Before I begin let me give you a little background. I happen to be a survivor of a stall/spin accident that occurred when I was younger, and it colored my approach to this problem. What we tried to do essentially was to make an airplane absolutely stall proof. It turned out that from this came a viable stall deterrent system which I will talk about later. Both of these concepts have been flight tested, so, with that I would like very quickly to cover what we did.

We conducted a 5-year study under the sponsorship of NASA Langley to look at active stall deterrent systems for general aviation aircraft. Most aircraft can stall and spin. We have a serious fatality problem in stall/spin accidents. We are currently using the pilot entirely as the controller, and while there are some stall warning devices, the pilot has to make the inputs. What we looked at were two approaches.

The first approach is to look at the aerodynamics, make the airplane stall proof aerodynamically. The second approach is to look at it from a control system approach and that is where we are. We claim that the state-of-the-art in electronics is moving a lot faster than anything in aerodynamics. And I am an aerodynamicist, so I have a little background in that area. We are going to look at helping the pilot directly. How to get between the pilot and the problem. We then decided to investigate the control system. But, in addition, in the general aviation environment, we must address the reliability of low-cost systems which is not a problem in military or in commercial systems. So, we are trying to look at a very simple system that will do the job. We covered five major areas. We first looked at a sensor which was very rugged, very simple, and very cheap. It is not an angle-of-attack sensor; it is related to angle-of-attack, but the wing stall phenomena drives the sensor.

We used the Langley general aviation simulator with a visual scene to consider the various concepts that you could use. It was a very nice way to look at problems. We conducted a flight experiment and looked at two systems. One intervened in the pitch and the throttle systems and the second was what we call an adjustable up elevator stop. I will explain what that means, later. It seems to me that the first is an intervention system, that is, there is an intervention between the pilot and the elevator. The adjustable stop is passive in the sense that it constrains stick travel, it does not directly intervene. Our test aircraft was a Cessna 310. It is a very good aircraft to explore stall/spin characteristics, because it has high-power loading, good spin characteristics and is typical of a lot of aircraft.

Let me quickly define what I mean by a stall deterrent system and, in particular, what I mean by an intervention system. We must have a sensor sensing some relationship to angle-of-attack at the onset of stall. You then must send some command to the system to give commands back to the elevator. And, of course, in this case of intervention, it's a summation of what the pilot puts in and what the control system puts in. In the intervention system, the pilot can pull the stick all the way back. The intervention system could command the elevator to a full-nose down position. And it turns out that if you wanted to deter against a rapid pitch rate you must give the system that much power. Also, if you are familiar with the Cessna aircraft at full flaps, there is a significant shift in the stick position for stall. Flaps up, the stick is all the way back. Flaps down, it is about mid-point, about neutral. So, it turns out that there is a large control variation in that aircraft. Therefore, we must command large elevator inputs in order to really make an airplane stall proof. If you really want to do it, you must give the system a lot of power. Let me just very quickly show how we intervened. The Cessna 310 had a nice control system. I don't have time to explain it, but essentially we had absolute redundancy in the system in that even if we had a lock on the actuator we could free it so we always could get the full control that is required.

Here is a quick time history of what the intervention system does. In a rapid approach to the stall, you quickly pull the stick all the way back. The airplane comes up to a certain angle-of-attack and does an oscillation. From a control standpoint, you don't like oscillations. From a piloting standpoint, it turned out the oscillations were very good cues to the pilot that something was up. The oscillation appeared to be a good indication of stall.

We concluded that the intervention system could absolutely prevent stall, no matter what the side slip and/or flap setting was.

Now, I would like to talk a little bit about what we call the adjustable stop where we took the acoustic sensor and rather than intervene in the system, merely said that when we approached stall at some angle-of-attack we limited travel of the stick. So, for a slow approach to the stall, it turns out it's simply a variable stop concept acting as a very effective stall deterrent device. If you keep the pitch rate down, there is no difference in effectiveness between the variable stop and the intervention system. Again it depends on the constraints that you want to work with. It turns out that you need something else to tell the pilot that it's on. If a pilot "feels" the system on, he tends to have a problem. And so there must be either lights or some audio signal going with the system. As it turns out, we think that a little bit of stick push tied into the system would also add to the effectiveness. We were not able to operate that system, but we feel that a cue of

stick pushing can easily be done with a pneumatic system that would add to the effectiveness of the concept.

Part of the program was an extensive evaluation flight test program using commercial and private pilots. One thing we found, which was very interesting to us, was when we showed the pilot a spin, the pilot didn't seem to know what to do about it. And, in fact, Gifford Bull had to intervene with two different pilots to make a recovery.

I will leave that observation for the workshop to ponder. But we did find that as part of our evaluation. Let me very quickly summarize our work — The Acoustic Stall Sensor is effective. It can be used over a wide range of operating conditions. Several aircraft have been used. The simulator is a great idea to figure out concepts, but it is not very good in inducing realistic stress conditions encountered in real world close-to-the-ground stall or stall spin situations.

To explore the real stress problems near the ground, we just didn't find the visual scene was good enough to be able to evaluate these concepts under stress where it really matters.

We looked at two concepts. The intervention concept is very effective, if we can solve the reliability problem. The variable up stop concept, I seriously think is at a level that could be certificated right now. The FAA and I will get together on that sometime. But it is at the point where we can certainly consider that part of the system. And the control laws are very simple. It doesn't take a very complex system to do the job.

Stall deterrents are a simple problem if you have the right input for that particular purpose, and that we seem to have. I will conclude with that very brief presentation.

DR. BERLIN: Thank you, George. One indication of the interest in general aviation research is the increased participation by leading organizations in the area of human factors research. The Aviation Research Center at Embry-Riddle University has been indeed fortunate to be able to team up with Dr. Wallace Prophet, one of the pioneers in this field, and his colleagues at Seville Research Corporation to perform several major research projects for the FAA.

I have asked Wally to present the results of the first of these projects to you today. In identifying and analyzing given human factors problems and issues for general aviation, the investigators have, in a sense, given us a valuable map by which further research can be planned and implemented. Wally?

DR. WALLACE W. PROPHET: Jerry has said the goal of this first task that we will talk about today was the identification of human factors problems in general aviation. Part of the impetus for this task was the constant high proportion of accidents that have been attributed to pilot performance problems. Although much progress has been made in general aviation safety over the past year, pilot performance problems are still a major and critical concern to general aviation. However, we have additional impetus for examining this area. That is our concern over projected changes in general aviation in future years and the possible impact of these changes on pilot performance. These include substantial changes in aircraft and avionics design due to the use of new technology, especially electronics technology, changes in air traffic control and flight service station operations with which the pilots interact, and changing demand for general aviation services.

The problem is that we do not know which of these changes will impact pilot performance or how. Thus, the FAA and the other organizations conducting human factors research are faced with a problem of determining how to identify existing or potential pilot performance problems, and how to develop efficient research programs to address these problems in order to produce information that can be used to aid the general aviation community to prevent or ameliorate these problems.

In recognition of this need then, the objective of this task was to identify major problems, either existing or potential, that may affect the safety and performance of general aviation pilots in future years. Also, the purpose of this task was to determine the types of human factors data required to identify and support actions to solve such problems and to analyze the implications of these requirements for planning human factors research activities in support of general aviation. Now, the first step in accomplishing these objectives was to develop a conceptual model that could be used to organize our analysis of pilot performance problems and to aid us in providing insight into the reasons behind these problems. As a basic premise for the model and to aid our understanding of the wide performance problems that occur, we borrowed a very simple concept from people at the Navy and Air Force Safety Centers. The view is that pilot performance problems arise when there is a mismatch of some sort between the task demands placed on pilots and their physical, physiological, and psychological capabilities to meet those demands. Obviously, the way to resolve mismatches and prevent these problems, is either to modify a task demand or to modify pilot capability to eliminate the mismatch between them or to do both.

Now, the paper you just heard is an illustration of one way to modify the task demands placed on the pilot. There are a variety of other ways that can be considered. To do so, it follows that we need to know which factors influence task demands and which influence pilot capability. We identified three major factors affecting task demands: (1) the design of the aircraft; (2) the design of airports; and (3) the design of what we chose to call aeronautical information systems, which are systems of documental information such as instrument flight procedures or real-time communications systems, like the air traffic control system which serves to prescribe actions to the pilot or provide him with information to help him make his own decisions.

We also identified three major factors affecting pilot capability. First, is the design of the airmen certification rating structure which started as a major mechanism for screening and selecting general aviation pilots. Second, is the design of training programs and associated proficiency evaluations for certificates and ratings. Third, is the design of continuation training activities and recurrent evaluations.

Now, these factors can be viewed as components in a system and one of the major design goals of the designer for such a system would be to insure that the task demands and pilot capabilities are in balance. That is that they match. The problem, however, is that there are no system designers responsible for all of these components, instead there are numerous individuals and organizations responsible for design of each separate component. Each designer has among his goals the responsibility to insure that his product will fit harmoniously into the overall system. The aircraft designer must consider pilot capabilities, for example; the program designer, because the training program is a part of the design process, must also consider the total set of demands that will be placed on graduates of the

training program. We have approached the problem then of identifying human factor problems as a system designed sort of activity. Now, when the human factors information base to support advanced design is lacking or absent, a human factors design issue can be said to exist.

The role of human factors research is to identify such issues, to aid in the identification of design operations that impact pilot performance, and to identify that impact and provide information to designers concerning these options and their possible impacts. From this then, we can say that a human factors research issue is a statement of the research required to address a design issue. That is, how to go about obtaining the information required to constitute the design of various systems and components. Given this model of pilot performance we are using, we were faced with the task of acquiring information which would aid us in determining what these human factors design issues were.

Our approach is basically in two parts. To obtain information, we reviewed a large number of reports and interviewed a number of individuals who were concerned with aviation safety and human factors research. This research was accomplished through several automated data bases, screening several thousand report abstracts and reading hundreds of research reports and documents of one sort or another. These reports were from a variety of sources: research studies, accident and incident reports, and articles in the popular aviation literature. We also manually searched through our own technical library at Seville and through the Embry-Riddle Technical Library. Additionally, we interviewed personnel at a variety of private and governmental organizations, and some of those people are here today. When all was said and done and we had sifted through this rather sizeable amount of information, we wound up identifying some 35 major human factors research issues. Now, keep in mind, these issues relate to the six-system components that we talked of earlier; aircraft, airports, training, and things of this nature. We do not have time to present all of them today. I encourage you to read the report: "Human Factors Problems in General Aviation" (FAA-CT-80-194).

I will present very briefly nine of the issues to which we gave the highest priority. Our priorities were based on three basic considerations. First, the amenability of the topic to quantification and conduct of empirical research. Secondly, the cost and practicality of conducting that research, and, third, the feasibility of implementing the results of the research if indeed the answers were determined. Obviously, there are many kinds of human factor problems that one could research and there might be no feasible way to implement the results. If that was the case, those items did not get very high priority.

The first issue that we will mention is the determination of requirements for a development of human factors standards and guidance for aircraft controls and displays. Displays and controls in general aviation aircraft are going to be substantially changed in future years, due to the increased use of airborne computers, advanced displays, and control technology. For example, the inclusion of cathode ray tubes, keyboards, and various other kinds of new devices in the general aviation cockpit. It will be difficult to make informed design decisions about such displays and controls, unless we systematically study the impact of various design operations on pilot performance and summarize the results of such studies in human factors standards and guidance. Here we are talking about more conventional evolution where you have the kind of displays and controls that we have become used to in general aviation. And I might mention that we have just instituted another research task that deals with this area of concern.

However, a closely related type of problem is our next issue. This is the determination of requirements and guidance for the design of integrated flight management systems. Now, here we are talking about the real impact of computer technology on the pilot aircraft interface in the coming years. We think, in addition to the evolutionary changes, there are going to be some very radical changes in areas relating to Data Link, fly-by-wire, such automation of various functions. Perhaps the pilots role is changing somewhat more to that of a systems manager and less of a controller. Programatic research is needed to analyze all of the functions of the pilots and using the systems approach to determine how the total pilot interface, the flight management system, can be assigned to optimize safety and performance.

The next issue deals with requirements for communications between general aviation pilots and air traffic control personnel. Air traffic control technology is also undergoing substantial changes now. By communications, we are not talking about just voice communications. We are talking about the advent of the Data Link and other kinds of technology on communications. We feel that research is needed to assure that these changes do not adversely affect the performance of the pilot. The issues we have been discussing up to this point deal with pilot task demands, that is, defining what the pilot has to do with the information he has to process and the kinds of decisions he has to make. They define his job as it were.

Now, we want to talk about a couple of issues relating to pilot capabilities. First, we feel there is need for identification of task subsets for current certificates and ratings. The airman certificate and rating structure has evolved over several years. Given the increasing change in civil aviation, no one really knows exactly what tasks are required of holders of various certificates and ratings. Systematic research is needed to define the tasks that different aviation pilots perform. Such mission and task analysis would serve as a comprehensive foundation for studies of the adequacy of the current certification and rating structure, and the identification of pilot training issues as well.

This leads to the next issue which deals with training requirements for certificates and ratings. The specification of what pilots do needs to be accompanied by a determination of what they must learn when entering into training to perform such tasks. For example, over the years, numerous independent proposals have been made to modify flight training to address various pilot performance problems. We had stall/spin training programs, instrument training, and so forth. However, the expected changes in aircraft and in the National Airspace System that will come will result in many entirely new training requirements. Thus, we feel research is needed to organize and provide a systematic flow of information concerning all training requirements for individuals involved in general aviation.

Flowing out of this, there is need to determine instructor training requirements. The flight instructor, after all, is the key to pilot training and in a very real sense is the most necessary part of the interface between the airspace system, the aircraft, and the pilot. Many of you build, and determine how a pilot is going to operate, aircraft in that airspace system. So, regardless of what kind of training programs we put together, we have got to consider the instructor-pilot as a primary key. Thus, we felt research should focus especially on his unique needs, particularly on requirements for teaching him how to instruct in many of these new areas.

There is a need, we feel, for determination of requirements for continuation training. One of the most urgent needs for research, with respect to determination of methods for improving pilot capabilities, lies in the need to develop information which can be used to improve the continued training pilots receive after they obtain a certificate or a rating. Some of this is formal training, some of it is at the individuals own instigation. This issue and two others deal with different aspects of continuation training. The other two issues are, the determination of requirements for recurrent review of the pilot proficiency and the development of guidance for structuring the biennial flight review. As I said, we have identified a number of issues and these are discussed at much greater length in the report. So, I urge you to examine them.

In conclusion, we can say that there is an urgent need for systematic human factors research. Such research would provide the comprehensive systems oriented data bases needed by individuals in the general aviation community who design the various components that comprise the general aviation system. Keep in mind that we are talking about the components, that includes the people as well as the hardware and the traffic control procedures. The need for such data bases is particularly acute in general aviation, because unlike military and air carrier aviation, industry often can't afford the front-end human factors required for new systems in general aviation.

It will also be extremely important to identify and develop mechanisms for facilitating the use and dissemination of research results. Now, research is sometimes opposed by persons who feel that it will lead to increasing government regulations. This does not have to be and should not be the case. We need to develop alternative methods of implementing research results. When they are practical, acceptable, and needed by the general aviation community, those research results will be implemented and used.

The time for action we feel is now. There are significant changes coming in general aviation. We need to develop the data bases to aid designers before these changes occur and sometimes bring these unanticipated problems with them.

We need to plan effectively for the changes and not wait for the serious problems to occur before we try to do something about it.

So, what we have sought to do here in this particular effort is to develop a structure for looking at all of the components of general aviation, identifying how they fit together, they must fit together in terms of an operating system in order to sense some of these pressure points before they become critical and we see them appearing in the accident statistics. Thank you.

DR. BERLIN: Thank you, Wally. One of the first issues addressed in our human factors effort was the appropriateness of the 200 hour minimum pertaining to the instrument rating. The number of weather related accidents occurring within the first 100 to 200 hours of the granting of the private pilot certificate was the stimulus for this concern. The logistics of researching this problem by a controlled experiment with an appropriate population, simply were enormous. Mr. Peter Denlea of Embry-Riddle and Dr. Jerry Childs of Seville Research will report on this effort, the last bits of data of which are just now being submitted. Pete?

MR. PETER DENLEA: My presentation will be on the effects of pilot experience on acquiring instrument flight skills. The impetus for the study comes from different areas. The first was a group of several studies done over the years, including one dating all the way back to 1934 by the Boeing School of Aeronautics relative to instrument training. The second was an NTSB study done in 1974 on fatal, weather-related general aviation accidents. And the third was a specific recommendation which came out of the 1979 First General Aviation Safety Workshop held at Ohio State University in 1979 and sponsored by AOPA and GAMA.

Now, the NTSB study on fatal, weather-related general aviation accidents pointed out and I quote "Weather is the most frequently cited cause/factor in fatal, general aviation accidents and has been for several decades." The report showed the following: The types of weather conditions which existed at the time of these accidents was not violent weather such as hurricanes and thunderstorms, but were predominantly benign weather conditions such as rain, fog, and low ceilings. This study, which covered a period of about 10 years, did support the desirability of moving the instrument rating closer to the private pilot certification.

The results of the first General Aviation Safety Workshop called for a specific look at "determining whether eliminating the 200-hour requirement of FAR 61.65 is reasonable." This recommendation came out of both the proficiency and recurrent training groups and the weather-related accidents group. Now, the data indicate that VFR pilots are finding themselves in various IFR conditions and are experiencing spatial disorientation with disastrous consequences.

The national flight time average to private pilot certification is 65 hours. These figures show that most instrument rated applicants are close to the 200-hour total time requirement when they come in for their instrument rating checkride. Additionally, most of these applicants are close to the 40-hour instrument training time requirement for their instrument rating. This means that most instrument rating candidates have somewhere around 160 hours when they commence instrument training. Now, the indication here is that most pilots build their time so as to allow their last 40 hours of instrument training time to count towards their total flight time training requirement for their instrument rating. In view of the high cost of flight instruction and inflation, it seems reasonable that this trend will continue and pilots will continue to fly around in the 65 to 160-165 hour range with little instrument instruction or experience.

Now, a frequency distribution of the total flight time of those pilots involved in fatal, weather/related accidents shows an elevation between 85 and 185 hours. In view of what I have presented, there remains the question: Is the requirement for 200 flight hours a desirable prerequisite in order to be instrument rated? The FAA Blue Seal Program instituted in the mid '70's, which calls for basic instrument training for private pilots, is indicative of FAA's interest in this area.

Having shown you the reasons for the study, Dr. Childs will now come up and give you the remainder of the presentation and show you what has been accomplished to date.

DR. JERRY M. CHILDS: Thank you. I will be briefly describing the design of this effort and talk a little bit about the performance measurement considerations prior to getting into the results. As mentioned earlier, we wanted to know whether the amount of total flight time, per se, would have an effect on the acquisition of

instrument flight skills. Thus, it was necessary to control for factors other than total flight time which may be expected to influence performance. The design provided for three training tracks which differed only with respect to when instrument training occurred for the tracks. These tracks were intended to provide a representative range of total flight time between 100 and 200 hours at the point in which the instrument checkride occurred.

There were three experimental groups, tracks A, B, and C. The training received prior to commencing instrument training was controlled to be contact training for all three tracks. Then instrument training was begun at a mean time of 67 hours for track A, 100 hours for track B, and 130 hours for track C. Following approximately 40 hours of instrument training then, track A's instrument checkride occurred at a mean time of 113 hours; Track B's time at a mean time of 138 hours, and track C's at 171 hours. It is important to note here that the content and the sequence of the training were, to the greatest possible extent within an operational context, held constant for the three tracks. Only the point where the tracks underwent instrument training was varied in terms of performance assessment. Student performance was assessed with a contact checkride given just prior to the beginning of the instrument training and an instrument checkride given at the end of instrument training. The contact performance assessment was intended to provide us with baseline data to determine whether the tracks were equivalent on contact skills prior to entry into instrument training. However, we were primarily interested in instrument checkride performance. Additionally, to provide some indication of the nature of performance change during instrument training, measures of daily performance were also taken. Today, we will concentrate on discussing the instrument checkride results.

The subjects were 79 Embry-Riddle students, 69 males and 10 females. None of the subjects had previous flight experience. The subjects were fairly uniform with respect to age, ratio of males to females in each track, and with respect to grade point average.

The performance measurement used in this study was objective. By that we mean, that it was based on observable aspects of performance and specifically it was based on comparisons of actual in-flight performance with desired performance levels. The technique used to measure student pilot performance is known as the Pilot Performance Description Record (PPDR). This is an objective performance assessment procedure that has been used in both military and general aviation for many years.

The PPDR is comprised of specific maneuver parameters such as air speed or track-to-station, and stated tolerances for those parameters such as plus or minus 5 knots of air speed, plus or minus 50 feet of altitude. In this study, these parameters and tolerances were defined in accordance with Embry-Riddle and FAA flight training guides and with the assistance of the Embry-Riddle check pilots who participated in this study. It should be mentioned here that the instrument PPDR, which was designed to measure instrument proficiency, was based upon existing FAA flight standards. Another characteristic of PPDR is that it provides for standardization in the administration sequence of checkride maneuvers. This results in a greater degree of measurement uniformity and hence increases the reliability and validity of the resulting data. The PPDR is in the form of a booklet of maneuvers to be administered in a prescribed sequence.

Now, I'd like to discuss just a couple of the results, overall results, of this effort. First, the PPDR error rates for the contact checkride in all three tracks, and then second, the PPDR error rates for the instrument checkrides. First, the contact checkride: As I mentioned earlier, we were interested in contact performance only as a background or baseline measure to tell us whether the tracks were essentially equivalent on contact skills prior to entering instrument training. The track differences from the overall mean were small. These differences were not statistically significant, this indicated that the tracks were not significantly different, with regard to contact flying skills, prior to entering instrument training. This, of course, provided us with a greater degree of assurance that any differences among tracks at the completion of instrument training would be a function of the amount of total flight time incurred, which is what we were interested in, rather than a preexisting flight skill difference between the tracks. So, this was just a control measure.

Now, for the results of the instrument PPDR administered on the instrument checkride for all tracks. Each subject had 98 possible measures. Again, deviations of the track mean errors from the overall mean error were small and not statistically significant. This, of course, does not mean that the tracks were identical with respect to instrument proficiency. It does mean that there were no overall statistical differences among tracks.

It should be noted that the rationale for additional flight time being necessary in order to demonstrate the flight proficiency required for an instrument rating, in this case, is not supported by these data. If more time resulted in better performance, track C's error rate — the high time group — should have been lower than A and B, not higher, as it was. So, the observed differences we got were not in the expected direction if you follow the flight experience rationale with a 200-hour time requirement.

Again, these differences are not statistically significant, but do indicate that students with fewer than 200 hours can be trained to instrument proficiency when the training program is carefully laid out and when performance is assessed according to well defined and published standards.

It should be mentioned that all subjects in each track passed their instrument flight checks, indicating that the flight standards designated by the FAA were met by all three groups.

From these data it can be concluded that the total flight time prior to beginning instrument training, at least within the range examined in this study, is not a significant factor in affecting acquisition of instrument flight skills. Rather, it seems to be a matter of how training is conducted. This was reflected in the subjective comments by the check pilots who participated in this study. Without exception, they felt that the 200-hour requirement could feasibly be reduced. Under the assumption that current standards of instrument skills are adequate and that quality assurance is provided by the instrument checkride, we conclude that overall instrument flight performance is not degraded by a reasonable reduction in total flight time prior to entering instrument training. The results show that we should not be concerned with experience, per se, as much as the fact that carefully defined flight standards for the instrument rating have been met. Thank you very much.

DR. BERLIN: The one serious limitation I see to this study is that it is done with a very specific population of student pilots at Embry-Riddle going for a degree in a certain environment. We are now in the planning stages to replicate this experiment using an entirely different population which more approximates the general aviation community. We are hoping to start this experiment soon.

Little research has been done in general aviation training, per se. One example of this would be the relationship of time to training effectiveness. How many times have students asked us how often they should take a lesson or how long should their training take. For certified pilots, questions often concern how often do they need to perform or practice different flight tasks in order to remain proficient. We have been attending to some of these questions. I have asked Dr. Jack Shelnett of Seville to report on this effort.

DR. JACK B. SHELNETT: Common experience indicates that our ability to perform complex tasks will degrade over a period of time if we do not perform or practice them regularly. Thus, if we try to perform a flight task on which we are a little rusty, we usually have a higher probability of making an error. Given the possible disastrous consequences of such errors, it would be beneficial to know how we lose skills and how to prevent such losses. There is a substantial body of psychological research which has been devoted to the study of skill retention and we have learned quite a bit about this problem. The general pattern for the loss of skill over time for complex psychomotor skills, like many of those involved in flying, is a rapid loss in the first few weeks, followed by a relatively slower loss. The same research has shown, however, that the specific relation between loss of flight skills and time is a function of a number of factors. Such factors include duration of the time period since the pilot received his training, the amount and type of flying he received during that period, the recency of performance of a given flight task relative to the testing of that task, the original level of the skill acquisition, and the type of task that is being performed.

Research has shown that it is relatively easier to maintain proficiency on tasks that have a higher degree of internal organization in comparison with less structured tasks. Given the number of factors affecting skill retention, it is necessary to study the particular effects of each of these factors on the specific skills that are of interest. In other words, if you are interested in the flying skills of general aviation pilots, you need to study the retention of these skills in relation to the factors. Unfortunately, there have been very few formal research studies which have addressed the skill retention problems of general aviation pilots.

Thus, there are almost no empirical data which can be used to develop systematic guidance to be used to plan initial and recurrent training for pilots, or in adapting biennial reviews of pilot proficiency to the most likely areas of skill loss. Given this lack of systematic guidance, we depend, to a large extent, on the individual pilot's own assessment of his training needs. For the most part, this procedure seems to work, but we are all familiar with accidents in which the pilot's assessment of his current proficiency was disastrously inaccurate. Thus, we also need information concerning the individual pilot's ability to assess his own training needs; to determine when he is likely to be right, and more importantly when he is likely to be wrong.

Given these needs, our research has three major objectives. The first objective concerned the determination of retention of private pilot flight skills over a 2-year period. We want to assess overall skill losses relative to such factors as level of learning and amount of flying since certification. We also want to assess retention of different types of flight tasks. The second objective concerns an evaluation of pilots ability to assess their own training needs. We want to investigate how well pilots can predict their performance, how well they can evaluate the adequacy of their performance on these tasks once they perform them. To aid in our understanding of flight skill retention, we added a third objective. This objective concerns the determination of the effects of differing distributions of flying time during training on retention of skills. What we decided to do during the original training was to vary the amount of calendar time spent while accumulating the 40 or so flight hours necessary for a private pilot license. One group finished this training in a relatively short period of time, while a second group was given twice as long to complete the training. As a result, we will be able to assess differences in patterns of skill retention during training. That is, we can assess the retention of tasks introduced early in training and not practiced again until late in training. Additionally, we will study how different description of flight time affects overall private pilot training effectiveness and efficiency.

The experimental design was relatively simple. We had two groups of subjects. One group was given 3 months and the other 6 months to complete private pilot training. During this training, pilots in each group were given four objective flight checks at the end of each major phase in the training program. After completing training, each pilot will receive a flight check every 8 months for a period of 2 years, a total of three checks in all. We used the basic Embry-Riddle pilot training syllabus modified slightly to meet experimental requirements and conducted the study at the FAA Technical Center.

It is important to note that the check pilot for a given student was not his instructor. We collected a substantial amount of data from the training, using a variety of measurement tools. The objective flight checks were similar in nature to the private pilot description record as was described by Dr. Childs for task 2, but we modified its use to include maneuvers and measurement parameters of particular relevance to the objectives of this study. We also administered several written tests to the students during their ground training. Furthermore, the students also had to take FAA written tests and private pilot checkrides with independent personnel.

In addition to these tests of skill and knowledge, we also developed special subjective surveys in which each student had to predict, task by task, how he felt he would do on a checkride before he took it. Additionally, after the checkride, we had them rate, task by task, how they felt they actually did. We also gave the students an opinion questionnaire which assessed their attitudes towards the training they received. During the retention interval, we will give the pilots the same experimental flight checks and written tests, plus the pre- and post-check surveys. We will also note their flight experience during this time. We are at present, just completing the training for the 6-month group. Thus, we do not have the results at this time.

When the study is finished, we intend to analyze the data in a number of ways. For example, we will assess retention of proficiency over the 2-year period on the different task maneuvers relative to individual differences; such things as the original level skill attained by the pilot during initial training and relative to the amount of flying they did during the retention period. We will also compare the performance of the students on two tracks to assess differences in the efficiency and effectiveness of their training. Finally, we will assess the relationships among pre-check predictions of flight performance by the students, the post-check self-evaluations, and a rating of their actual performance by the check pilots. The results of these analyses should provide us with information we can use in developing systematic guidance for the conduct of proficiency training and have recurrent reviews of pilot proficiency. Hopefully, flight instructors will be able to use this as a guidance to aid in their conduct of these activities. Thank you.

DR. BERLIN: Thank you, Jack. In reply to my call for papers, Hubert "Skip" Smith of Penn State University responded by suggesting that he report on either of two studies in which he is currently engaged.

We have asked him to report on his studies of Traffic Pattern Habits at Uncontrolled Airports. Before I ask Dr. Smith to present his paper, I would like to read a quote from his letter to me. He said, "I would therefore appreciate being informed of any activities in this area of aviation research, and I am willing to cooperate in any venture which would be of benefit." It made me feel that this could be one of the greatest contributions of this kind of workshop to bring together in cooperative ventures professionals such as "Skip" Smith.

DR. HUBERT C. SMITH: Thanks very much, Jerry. We have established within the Department of Aerospace Engineering a small aviation program, as sort of an outgrowth of the Aeronautical Engineering Program and as Jerry said, I am really the only person active in this facility. We do have a Department Head, a pilot, and the university backs the program wholeheartedly, so that is a big help. I am very happy to be here and I feel particularly fortunate in that I chanced to fly through Philadelphia TCA the day after the Eagles lost the Super Bowl.

We attempted to look into some of the habits of pilots at uncontrolled airports primarily because reports indicate that most midair collisions, and this is from FAA studies, occur at or near an airport facility usually below 5000 feet. Secondly, that airport is uncontrolled, and, thirdly, the weather is usually always VFR, contrary to what we might suppose would be the "ideal" conditions for a midair collision.

Considering these facts, as a first step in studying habits at an uncontrolled airport we decided to start off on this project looking first at the methods in which pilots approach such uncontrolled airports. We took the standard traffic pattern that you see in the AIM and we just divided it up into different methods of entry into the standard pattern. Now, you may or may not recall that the regulations state (referring now to FAR Part 91, specifically) that when you approach an uncontrolled airport you make all turns to the left unless displays indicate otherwise. That is the only regulation that applies. The AIM recommends a standard method of approach, namely, the recommended method of entering 45° to the downwind leg, although there is nothing illegal about coming straight in or crosswind, or whatever. Well, we happened to have a little airport up there that lent itself very well to this sort of program.

We came up with a questionnaire, very simple in nature, that would encourage maximum participation. It requested information of individuals as, for example, which entry did you make into the pattern, what type of pilot certificate do you hold, how many hours do you have, what is your aircraft classification. We then divided this last one into single engine, twin engine, piston, turboprop, and jet, and then also very significantly, what was the amount of traffic, other traffic, in the pattern at the time of entry.

We took our own airport there which seemed to be quite a good one to use. It's a typical small airport which formerly was used for nothing but flight training for ROTC students, but now has evolved into quite a corporate operation for many of the local industries and the university. And there are now 20 scheduled flights a day of commuter operations going in and out of this place. Those include numerous business aircraft, many jet aircraft, Piper Navajo aircraft, standard single engine and turboprop, Beech 99's, Twin Otters, and we have even Nords coming in there. So, there is quite a mix in traffic in this pattern. We are located just off the Phillipsburg VOR, right in the geographical center of Pennsylvania. We now have an ILS approach on our primary prevailing downwind runway. There is also an approach off the Phillipsburg VOR.

Over a 3-month period we sampled about 125 to 150 pilots. We proceeded with the help of others to conduct a survey, a sampling of a varied number of pilot certificates and observed how various aircraft entered the pattern. It was found that of those who made the recommended pattern entry, and that is the 45° entry into the downwind, that 94 percent of such entries were made by private pilots. We found the figure to be much less when we went to commercial and airline transport pilots. Now, we weren't sure whether this meant really that this was a result of good training which carried over into their actual practice or whether many of the private pilots perceived this to be the legal way of doing it; and, therefore, were reluctant to admit any other type of entry. At any rate, we broke this down a little more and looked into all of the various means of entry and we found that since there was an ILS on this primary runway, a lot of commercial operations probably came straight in because they were coming in off the ILS and a lot of crosswind traffic came in off the VOR approach.

We conducted this survey in VFR weather. We cannot rule out the fact, however, that many pilots utilized the IFR flight plan or made somewhat of an approach from the approach facilities. We went on to sample the type of airplane, and again this pretty much backs up what we learned with the pilot certificate sort of thing. Since most private pilots are flying single engine airplanes, we found the highest classification of airplane that made a standard pattern entry was the single engine.

Now, another significant result then was when we asked how many other airplanes were in the pattern at the time you entered and we compared the number of standard entries. This is again what we call the standard 45° into the downwind. Now, with none in the pattern, it was the lowest percentage, but as the number of aircraft increased, all pilots and all types of airplanes tended to make more standard entries, which seems to be somewhat of a kind of encouraging sign to a realization that perhaps we are following the regulations or following the recommendations, I should say.

This is, as I said, a very brief study at one airport, but it does point out that many of our airports which are uncontrolled now are becoming pretty complex airports with commuter operations beginning to serve quite a number of small communities. These communities still have a lot of general aviation airports with a lot of training going on, with a lot of just plain sport flying going on and we are getting quite a mix of different types of aircraft such as we encountered years ago at our major terminals. So, I think that studies like these are important and I would like to see them continued a little bit. We would like to continue these studies by not just relying on questionnaires but doing some actual observations and doing it at a few more airports. Thank you very much.

DR. BERLIN: About 4 years ago, FAA's Flight Safety Branch was asked to investigate ways of improving the training of good judgment. The first contract was awarded to the University of Illinois to establish a definition of pilot judgment and to investigate ways of improving it. Dr. Dick Jensen and his associates did what I just have to call a heroic job of integrating diverse and sometimes conflicting psychological theory and findings; he did this in order to arrive at a workable definition of the concept of judgment.

The follow-on contract was awarded to Embry-Riddle Aeronautical University for the purpose of preparing an actual training syllabus and developing a methodology for testing that syllabus. The training syllabus is in the final stages of completion at this time. Looking at past training methods in this area, a discrepancy between teaching good judgment and actually implanting it in the students behavioral repertoire was found. It was decided to try some very novel and unusual training techniques. I have requested that Dr. Charles Holmes give you a synopsis of the efforts in this area. Chuck?

DR. CHARLES HOLMES: Good afternoon. The purpose of our program is to improve pilot behavior associated with judgments. In conjunction, an experimental method to test the judgment program was developed. These results are contained in three volumes; Volume I contains the concepts upon which the program is based and a suggested evaluation methodology. Volume II, The Student Manual, contains the instructional material in the judgment training program and the companion work sheets by which the student may determine his or her own progress. Volume III, The Instructor Manual, provides the instructor with a systematic approach to administering the judgment training and in evaluating the performance of the students.

The overall approach in the program addresses judgment behavior of the pilots, by using self-assessment to determine poor judgment tendencies, role modeling of the instructor, and accepted principles of learning. We have agreed, in principle, with the definition of judgment offered by Dr. Dick Jensen in his earlier study. However, we felt that this definition should be a little more specific and should be operationally based. Pilot judgment is therefore defined as a mental process in which the pilot recognizes, analyzes, and evaluates information regarding himself, the aircraft, and the outside environment. The final step in this process is the making of a decision pertaining to the operation of the aircraft.

The Student Manual contains 20 lessons which are divided into three units. Unit I presents concepts and materials which are used throughout the judgment training course. These terms and concepts have been especially designed to lead the student into the modified patterns of thinking which we feel will ultimately produce better judgment.

Four sets of new terms and concepts are presented. The first of these sets introduces the student to three subject areas relevant to pilot judgment: the pilot himself, the aircraft, and the environment. Conventional flight training deals primarily with the subject areas of aircraft and environment. The judgment program emphasizes a pilot's need to know more about himself, how he interacts with the aircraft and the flight environment, and how the three interact among themselves.

The second set of terms is called the six Action Ways. Nearly 600 NTSB accident briefs were examined to determine how the pilots carry out the actions resulting from immediate decisions. It was obvious that pilots implemented poor judgment decisions in six ways:

1. DO, the pilot did something which he should not have done.
2. NO-DO: The pilot did not do something that he should have done.
3. UNDER-DO: The pilot did not do enough when he should have done more.
4. OVER-DO: The pilot did too much when he should have done less.
5. EARLY-DO: The pilot reacted too early when he should have waited.
6. LATE-DO: The pilot reacted too late when he should have reacted sooner.

The repetitive use of these terms is designed to effectively and positively identify the actual, erroneous responses simultaneously with the desired responses.

The third set of new concepts is called Poor Judgment (PJ) Behavior Chain. Research into accidents shows that once a poor judgment is made, there almost always follows a sequence of additional poor judgments. As the chain of poor judgments grows, it stands to reason that the number of safe alternatives diminishes very rapidly. If this sequence or chain is broken early in a situation, the pilot may have more alternatives for successful recovery. In the judgment training material, the phenomenon where one poor judgment leads to another, is referred to as the PJ Behavior Chain. This section teaches the student about some of the chain mechanisms and what must be done in order to break this chain. The judgment program uses elementary behavior training to trigger within the student pilot a new response pattern to effectively break the chain.

With the fourth set of concepts, a student is taught to understand and apply the three mental processes of safe flight: (1) "Automatic Reaction" — Two general categories of automatic reaction are taught. One involves the flight skills having to do with maintaining positive ongoing control of the aircraft. The other concerns those learned responses to unusual or emergency situations. (2) "Problem Resolving" — The mode of thinking that helps a pilot overcome undesirable situations by means of a systematic process. (3) "Repeated Reviewing" — The mode of thinking that allows the pilot to continuously be aware of all the factors, that is, the pilot, aircraft, and environmental factors that effect safe flight.

Unit II contains the behavioral aspects of the judgment training. This unit is designed to adjust or to redirect a pilot's tendencies in such a way as to promote the consistent use of good judgment. The first approach addresses the pilot's hazardous ways of thinking, his hazardous attitudes. Five hazardous thoughts for

pilots are identified and an exercise for self-assessment of these hazardous thoughts are provided in the Student Manual. Since little or no prior research was found in which such thought patterns were investigated, it was necessary to consult experts to obtain opinions of the nature of such hazardous thoughts and of course to provide them with generic names:

1. "Anti-authority": "Don't tell me what to do", or, "no one can tell me what to do to fly my airplane."

2. "Impulsivity": "Do something quickly."

3. "Invulnerability": The thought pattern of the person who thinks "It won't happen to me, maybe to others, but not to me."

4. "Macho": The thought that "I can do something the others may not be able to do, but I certainly can." (The name may have been a mistake, it's not restricted to men as we see it.)

5. "Outer Control": People having this thought pattern feel they can do little, if anything, to influence what happens. Therefore, they generally do nothing, which is characterized in the Student Manual by the phrase, "What's the use?"

I would like to emphasize that these selected hazardous thoughts are preliminary only. Additional research and validation of the judgment training program is needed in order to fully develop this concept.

In the program, students are taught to identify and understand the five hazardous thoughts. A lesson is devoted to each hazardous thought. Following these lessons, is a lesson which specifies substitute thoughts called "antidotes for the five hazardous thoughts."

Unit III contains written lessons to relate the concept of units I and II to actual flight situations. No new flight or judgment material is taught. The unit is made up of numerous exercises centered around scenarios and case histories of pilots carrying out flight activities. The scenarios and histories are taken from reports of actual accidents and incidents which occurred within the last 5 years. The unit is intended to make judgment training seem real, to make it come alive for the student. We feel that a sense of relevancy, of personal involvement, is essential for the new behavioral learning to take place.

The Instructor's Manual outlines for the instructor the material contained in the Student Manual. It explains how the instructor is to present the material to the students and provides guidance on how to resolve students' difficulties regarding the judgment training course. In addition to describing how the instructor should present the program, the Instructor's Manual contains material designed to enhance the influence of the instructor as a role model for the student. Finally, the Instructor's Manual contains two sets of exercises for the instructor to conduct during flight training activities. These exercises are designed to further develop and focus the student pilot's judgment-making abilities as well as to reinforce the conceptual and behavioral aspects of judgment training. The exercises are generally completed in conjunction with other flight activities. Thus, the increase in flight time required for the student to complete the judgment training is therefore minimal.

It was the intent of this research to produce an experimentally derived judgment training program. As of yet, no construction testing has been done to verify either the appropriateness or effectiveness of the training increments making up the program. Only through such testing can we know which materials and sequences are optimal. It may be shown by empirical testing that we have constructed too much material, that it needs a different order of presentation, or that different materials need to be developed. We therefore recommend that a validation of the program be conducted under controlled conditions. Finally, the program should be assessed for suitability in other areas of aviation and its adaptability in other endeavors such as driver training and heavy equipment operations. Thank you.

DR. BERLIN: Well, there you have it. I tried to choose a diverse selection of reports so that you could get some feel for the kind of work that is being done in general aviation research. Many of these researchers who reported to you today reported on work that was recommended by you at the last General Aviation Safety Workshop. I certainly hope that we can do the same in this workshop, so that 2 years from now we can report to you on things that you recommended this week.

I would now like to open up the floor for questions. What I would like for you to do is for you to raise your hand, tell us who you are, to whom the question or comment is posed and if that speaker will then stand up and receive it, we can have some good interaction.

MR. JACK ENDERS: Jack Enders, Flight Safety Foundation. I have a question for Dr. Smith from Penn State. What was the size of the population that you studied, I believe you gave the percentage breakdown?

DR. SMITH: We had about 125 of these questionnaires filled out. That is our sample. Total population was a little harder to determine because we really don't have a record of the total operations at the airport. I would guess we are talking about 1 percent to 2 percent of the operations.

MR. ENDERS: Thank you very much. Well, will you take one more question?

DR. BERLIN: Yes, of course. We appreciate any comments you might have.

MR. ENDERS: This question is for Dr. Childs. On the track system that you described, Tracks A, B, and C, I am curious to know just how these tracks were determined. Were these tracks established for different time phasing of student groups, or were they put together on the basis of aptitudes, putting bachelors in one group, and so on?

DR. JERRY CHILDS: No, sir. They were selected on the basis of the problem in view of the accident data, the NTSB accident data, which indicates a high involvement of low-time pilots in weather-related accidents. What we did was to provide a representative range of time from 100 to 200 hours of flight time when they took their instrument training. We had a good mix on the basis of the student population we were using. We had the low-, intermediate-, and high-time groups, with the high-time group — Track C — being most representative of the general population of student pilots that come in for an instrument checkride at about 200 hours of flight time.

MR. ENDERS: You answered the other question I had when you presented it. You are going to take this away from a structured university environment to see how it would work.

DR. BERLIN: Yes, sir?

MR. FRANK KINGSTON SMITH: My name is also Smith. I am a local pilot and I have attended many of these workshops. I had spent about 10 years in Washington D.C. and had attended a lot of meetings of this type. Now, since I have retired from the cycle and am now back here flying again as a weekend pilot, so to speak, I would just like to call to mind the fact that I have found that there are a great many people over the age of 30, or from 30 to 40, who are now getting enough money together to start to learn to fly because they want to do it for fun. And I'd be very interested to see what the statistics show about accidents in the older group of pilots who learned to fly recently and the methods under which they are taught. Obviously, there is a different group there from what you have in the controlled situation such as you have at Embry-Riddle or in the military. I think this is also something most of us tend to skip over.

DR. BERLIN: Thank you, Mr. Smith. There is a small research project ongoing now at UCLA by a colleague of mine who is studying effects of flying on this new pilot age group. The results will be out in probably 6 to 8 months.

MR. BUD STACK: I am Bud Stack from Gulfstream American. I will direct my question to George Bennett and Chuck Holmes, and maybe even to the working group on the economics of safety tomorrow or perhaps even to some of the people who explore the budget on research around here. My question is, if I have X amount of dollars to spend on research, and we will use the example we just had on reducing accidents related to stall/spin, do I send it down to Mississippi State and focus on the airplane or send it down to Embry-Riddle and focus on the pilot? I was thinking hopefully we could coordinate these to get the best use of the research dollar.

DR. BERLIN: Does anybody want to comment on that? Chuck Holmes.

DR. HOLMES: I would say that you should not put all of your eggs in one basket, so to speak. You have to go both ways. We can make stall warning systems, stall prevention systems more automatic, you always have a lot of leeway there. Let's see if we can do it in both directions. I think they are both well worth investigating, but we should not forget the pilot, the human element, which I think is probably the most important element and most overlooked element in the industry today. I hope that answers your question.

DR. BERLIN: Mr. Bennett?

GEORGE BENNETT: I'd like to respond. I didn't have time to mention it, but another constraint on our study was trying to keep the price of a system below \$1,000, that is on any active system, and the variable stop system looks like we are talking numbers of less than \$500, a very simple system, so the cost is pretty low now. It depends on what your certification costs are.

DR. BERLIN: Yes, ma'am.

MS. HAZEL JONES: I am Hazel Jones with the 99's Women Pilots. I was happy to note that all of this was directed towards the males, not the females today, but I particularly am interested in knowing if the information on teaching good judgment is going to be made available to anyone other than this group, or is it available now?

DR. BERLIN: We have submitted the final draft. It is now being reviewed by the FAA managers who audited it. There is, of course, a lot of research testing to go on in the future but the results of our work should be out in the very near future. We will take the responsibility, however, of issuing to each of you a sheet telling you how you can get this material.

DR. BERLIN: Yes sir.

DON BALDWIN: Don Baldwin, Flight Safety International. Obviously judgment has a great deal to do with knowledge, how did you relate knowledge and judgment in this study?

DR. HOLMES: That was one of the first things that we investigated, how do you separate knowledge from judgment. That is why we defined judgment as we did. We made it an operational one; the failure to recognize that you as a pilot do not have the knowledge to go out and do what you want to do is a bad case in judgment. Failing to recognize that you do not have the background, the knowledge, to go out and fly through a thunderstorm or have an aircraft that is not properly equipped, is exercising poor judgment.

DR. BERLIN: I'd like to take a crack at that. Now, that aspect that Chuck mentions, of course, is part of the good judgment system. But in analyzing the 620 accidents we went through, and I can tell you that I read all of them, you can't help coming to the conclusion over and over again, that the cause of the accident, most often, was not a lack of knowledge.

DR. BERLIN: Yes, sir.

WIN KARISH, FAA: It seems to me that the end result is really behavior modification in the sense that it is unique to flying. What if that behavior modification conflicts with the basic behavior of the individual in his total life style? There seems to be an area of conflict here that I can't resolve.

DR. BERLIN: What we have tried to do with the judgment program is to implement what we know and understand as being behavioral modification and associated techniques. I think the question you put, and you did put it simply, will have to have an empirical answer. We will have to test the behavior modification where it conflicts with other needs in his life. And when I use the phrase "his needs" we made an assumption in the testing which may prove wrong, that using "good judgment in flying" so as to stay alive is generalizable to real life, to the other life situations. But, you know, that may not be so. Can you give us an example where a such conflict might exist, or can anybody?

MR. KARISH: Well, I think a typical example would be one which we hear of statistically all of the time, the doctor-lawyer syndrome. You know, I don't want to single them out particularly; but the idea being that the doctor in today's society must get someplace for an appointment, where he is living in a very concise

timeframe, where his time is valuable. He had to get there, and of course if you want to put dollar signs on it, the fact is he has to get there. In that sense, his judgments are motivated by that life style. How do you then oppose that with trying to implement the behavioral modification in just that one area of flying? How do you take the individual and remodify his total way of thinking? It just seems insurmountable to me and maybe I am wrong.

DR. BERLIN: Maybe what you are now talking about is the concept of calculated risk, where he says this is dangerous but I have to get there.

MR. KARISH: That's why they kill themselves.

DR. BERLIN: Well, one of the problems with this is that the more he does it and doesn't get killed, the more reinforced he gets in his thinking for doing such things, and so he continues to do this until he finally does get killed.

MR. GIFFORD BULL, MISSISSIPPI STATE: That of course is a common problem in flight instruction. Because these are the people with the money. The flight instructor, if he is any good, will spend quite a bit of time talking about that, explicitly. He will say, this is a problem that will occur with you more than with other people. And so you must learn that when you are thinking about flying, set aside your other concerns and think now, let's think strictly about flying. And it may not be easy to do, because you will have those pressures on you, but it is worth your while to save your neck. So the good flight instructor does try very hard to bring this out explicitly. He doesn't always succeed, but he tries.

DR. BERLIN: By the way, I think it is important for you all to understand that this judgment program as it exists today is very dependent on the behavior of the flight instructors. So that what you said was very congruent with our approach to this by using the flight instructor both as a reinforcer and as a psychological facilitator to help the student improve his judgment behavior and that would be very appropriate with a person such as a doctor or a lawyer.

MR. DON BALDWIN, FLIGHT SAFETY: I used to think that judgment was a factor of stupidity or lack of it; but I am convinced that judgment is a factor of retained knowledge and I would like to emphasize retained because I believe that our methodology in teaching does not lend itself to retained knowledge.

DR. BERLIN: We have a genuine disagreement, because I really do believe, that in the management of judgment errors, that is not true. That is just a personal difference and it would be wonderful in the years to come to do empirical research. One of the reasons I believe it is not true is because of my own personal experience and the other reason is as an aviation scientist. The one time that I did this I almost killed myself, at that time I had all the knowledge I needed to make a no-go decision and I made a go decision, traveling in 500 to 900 foot overcast in rime icing weather going down in the terminal area. I shouldn't have taken off, but I did because there were three sisters waiting at the other end and I didn't want to show them that I was a weakling and that I couldn't fly a plane. Now, I would be suspicious of this, as one example, except for the fact that I see in accident investigations so many like that.

MR. BALDWIN: I suggest that may be stupidity rather than judgment.

DR. BERLIN: Oh, I agree. Now you are not talking about knowledge, you are talking about stupidity. Judgment has many, many synonyms.

DR. RICHARD JENSEN: I am Dick Jensen, formerly with Illinois. One other aspect that concerned me from the beginning was the problem of training instructors clinically to teach this kind of thing. Have you grappled with that problem?

DR. BERLIN: Dick, we are in the initial stages now of talking with a major aviation organization about doing some experimental work with groups of flight instructors in trying to teach them the concepts of judgment that we have developed and seeing if that has an effect on student training. I can take one more question.

MR. ROBERT WRIGHT: My name is Bob Wright. I am an auditor with the general accounting office (GAO) currently doing a review of the FAA general aviation programs for the Congress. I have one question. First of all, concerning the review of the instrument rating procedures, did the group consider the fact of the typical general aviation pilot, in progressing up to a complex airplane as they would do, or were you training these typical general aviation pilots in an aircraft such as the Cessna 172 or other aircraft used by instructors?

DR. JERRY CHILDS: The aircraft used in the study were all Cessna 172's. Dr. Berlin has already mentioned the replication effort currently being planned in line with that and as a part of the effort, yes, we do intend to look at more complex aircraft.

MR. WRIGHT: One more question concerning other research on the effectiveness of various FAA regulations regarding proficiency such as the biennial flight review or the 90-day currency requirement, has anything been done in that area recently?

DR. BERLIN: I will answer that first and I will certainly open it up for discussion. But I have felt for a long time that we need to improve our biennial review procedures. It is a pet peeve of mine. It's on the books and I don't think it is being optimized. I don't know what anybody else has done, can anybody throw light on the subject?

UNIDENTIFIED VOICE: I would like to comment on the skill retention work that we are doing here. One of the purposes of the 2-year period of work is to identify the problem areas which exist or where something was going wrong, and I feel that once you identify what those problems are, which tasks people are not retaining you have the basis for restructuring the BFR. So that once you have identified areas where people seem to fall off after a given time period relative to their flying, then you can plan training to adjust to that. I think more research needs to be done. I think probably the biggest problem is not with the private pilot but with the instrument pilot. There are substantial problems with the private pilot shown by some of the tests on the weather-related accidents.

DR. BERLIN: By the way, I have come to know in our research work many of the FAA people, especially here at the Technical Center, and I grow somewhat impatient when I hear people who don't know these workers here as well as I do say such things as the FAA, when in doubt, they regulate or they really don't want to change. That is really not true. The people that I have worked with here at

the FAA are very willing to do away with and modify regulations if they are not appropriate, and more power to them. They really are taking that position and I want to tell you I feel there is a prejudice from some of the outside aviation agencies about the FAA that I feel is entirely wrong. I found a willingness to change and, a flexibility that really surprised me.

I just want to give you my personal good wishes for success this week. It's a good group. I can see how well you have related with each other. Let's have a good 2 days together and 2 years from now we'll meet again and see what we have accomplished.

## SPEAKER BIOGRAPHIES

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EMBRY-RIDDLE AERONAUTICAL UNIVERSITY

Dr. Berlin is Professor of Aviation Management and Director of the Embry-Riddle Aviation Research Center. He received his Ph.D. from the University of Chicago and served on the faculty of the University of Wisconsin and the University of Haifa. In 1962, he founded the Human Development Institute which was acquired 5 years later by Bell and Howell Corporation. Dr. Berlin served as Vice President of that organization until 1971, when he moved to Israel. He then served for several years in the Israel Air Force terminating his service as Chief of Training Research and Development with the rank of Lieutenant Colonel.

GEORGE A. BENNETT, Ph.D.  
DIRECTOR OF THE RASPET FLIGHT RESEARCH LABORATORY  
MISSISSIPPI STATE UNIVERSITY

Dr. Bennett is Professor of Aerospace Engineering and Director of the Raspet Flight Research Laboratory at the Mississippi State University. He received his Ph.D. from the University of Illinois, and was on their faculty. Dr. Bennett has served as an aerodynamicist in industry, was appointed as a National Aeronautics and Space Administration Faculty Fellow, and has served as an expert witness in aircraft accident litigation. He is an active commercial pilot with a glider rating.

WALLACE W. PROPHET, Ph.D.  
PRESIDENT, SEVILLE RESEARCH CORPORATION

Dr. Prophet, who holds the Ph.D. degree in experimental psychology, has been involved with human factors research and development for over 20 years. He is currently President of Seville Research Corporation and serves as a Program Manager for a variety of research projects. These projects include the study of a wide range of human factors considerations in complex man-machine systems, particularly aviation systems. Such considerations vary from man-machine interface design and evaluation, to selection of personnel, design and development of training systems, and human performance evaluations. Prior to establishing Seville, he was Vice President and Division Director for the Human Resources Research Organization (HumRRO). While with HumRRO, he managed and conducted an extensive number of research projects addressing human factors problems in military and civil aviation. Dr. Prophet is a private pilot, a licensed psychologist, a Fellow of the American Psychological Association and American Association for the Advancement of Science, and a member of the Human Factors Society, Association of Aviation Psychologists, Phi Beta Kappa, and a number of other professional and honorary societies. He has authored and coauthored numerous publications, including the recently published Federal Aviation Administration report, "Human Factors Problems in General Aviation," (FAA-CT-80-194).

E. PETER DENLEA  
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EMBRY-RIDDLE AERONAUTICAL UNIVERSITY

Mr. Denlea completed 25 years of active Naval service in 1977. During his Naval career, he progressed through the ranks to Lieutenant Commander. Mr. Denlea specialized in aviation maintenance and personnel management, holding both operational and staff positions in squadrons and on the Navy departmental level. As a Naval Flight Officer, Mr. Denlea accumulated over 4,000 hours in carrier tactical aircraft. His experience includes intercept, bombing, reconnaissance, and carrier-based antisubmarine warfare. Mr. Denlea has over 400 carrier landings as well as 50 reconnaissance combat missions over North Vietnam. A qualified mission commander, he maintained his combat readiness and instrument qualifications through 18 years of carrier flying. Mr. Denlea originally came to the university as the administrative coordinator for the Aviation Maintenance Division but soon transferred to the Aviation Research Center. Mr. Denlea is currently the Associate Director of the Aviation Research Center and the Center's chief administrative and operations officer.

JERRY M. CHILDS, Ph.D.  
PROJECT DIRECTOR, SEVILLE RESEARCH CORPORATION

Dr. Childs, who holds the Ph.D. in experimental psychology, is currently a Professional Associate and Project Director with Seville Research Corporation. He is responsible for the planning and conduct of projects addressing human factors considerations in general aviation. Dr. Childs was formerly a Staff Scientist and principal investigator with Canyon Research Group, Incorporated, and was responsible for the development and evaluation of inflight performance measurement methods to be used in the assessment of Army helicopter pilots. Prior to entering applied research, he served as Associate Professor of Psychology at a private, 4-year university. A licensed psychologist and private pilot, he is a member of the Human Factors Society, the Association of Aviation Psychologists, and the Aircraft Owners and Pilots Association. He has authored or coauthored numerous technical and professional publications including a chapter addressing performance assessment in Roscoe's Aviation Psychology and a recent Federal Aviation Administration report, "Human Factors Problems in General Aviation," (FAA-CT-80-194).

JACK B. SHELNUTT, Ph.D.  
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Dr. Shelnut, who holds the Ph.D. degree in human factors, is a Professional Associate and Project Director with Seville Research Corporation. At present, he is responsible for a number of research projects addressing human factors problems that affect the safety of general aviation. His other research activities with Seville have also been concerned with a variety of human factors problems in both military and civil aviation. Prior to joining Seville, he served as a Senior

Operations Research Analyst with the Litton Mellonics Corporation, a Naval Aerospace Psychologist with the U.S. Navy, and an Assistant Professor with the University of Indiana at Fort Wayne. Dr. Shelnutt is a private pilot and a member of the Human Factors Society, American Psychological Association, the Association of Aviation Psychologists, the American Institute of Aeronautics and Astronautics, the Institute of Electrical and Electronic Engineers, and the Phi Beta Kappa and Phi Kappa Phi Honorary Societies. He has authored and coauthored numerous publications, including the recently published Federal Aviation Administration report, "Human Factors Problems in General Aviation," (FAA-CT-80-194).

HUBERT C. SMITH, Ph.D.  
ASSISTANT PROFESSOR OF AEROSPACE ENGINEERING  
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Dr. Smith holds BS and MS degrees in Aeronautical Engineering from Penn State, as well as a Ph.D. from the University of Virginia. A pilot since 1952, Dr. Smith holds a commercial certificate, instrument rating, and flight and ground instructor certificates. He is also a Federal Aviation Administration Accident Prevention Counselor and a Written Test Examiner. Dr. Smith is the author of an engineering textbook on flight testing and a number of technical papers on aerodynamics and flight mechanics. He has also contributed articles to popular aviation magazines. He holds membership and various offices in the American Society for Engineering Education, the American Institute of Aeronautics and Astronautics, and the American Society for Aerospace Education.

CHARLES W. HOLMES, Ph.D.  
SENIOR RESEARCH SCIENTIST  
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Dr. Holmes is a Senior Research Scientist at the Aviation Research Center and Assistant Professor of Aviation Management at Embry-Riddle Aeronautical University. A commercial and instrument pilot with over 7,000 hours of total flying time, he has extensive experience in aviation and research. While on active duty with the U.S. Air Force, he held positions as wing flight safety officer and as chief instructor pilot in a multiengine pilot training school. Prior to joining Embry-Riddle, he was a member of the technical staff of the BDM Corporation, McLean, Virginia, where he held research, development, and project management positions. He was a teaching Fellow at Florida State University while obtaining his Ph.D. in education management and finance.

In addition to the development of the Civil Aviation Pilot Judgment Training and Evaluation Manual, his recent research experience includes that of being the contractor program manager for the Naval Aviation Zero-based Billet Analysis. During this effort, he developed a methodology for determining the minimum number of naval aviators required to maintain combat readiness. He has also conducted analytical studies for the U.S. Army Combat Development and Experimental Command, the United States Readiness Command, TRW, Martin-Marietta, and the Commander-in-Chief, Atlantic.

SECOND PLENARY SESSION — January 29, 1981

MR. HARVEY: For those of us that have not met, I am Doug Harvey from the FAA Technical Center. Before I begin, I think it is highly appropriate that we all acknowledge the two people that originated the General Aviation Safety Workshop concept, Gary Livack from GAMA and Russ Lawton from AOPA. I would now like to present Mr. Ralph Nelson who is the Senior Vice-President, Operations, of the Aircraft Owners & Pilots Association.

RALPH NELSON: Thank you, Doug. I think a few remarks are in order to describe exactly what is going on here. It is industry working hand and glove with the FAA for a common cause, safety. In the industry we are frequently pictured as being at odds with each other. We disagree sometimes, certainly, and when we do, we go at each other hammer and tongs. But I think what you have participated in here these last 3 days has been a finer example of what can happen between industry and the FAA.

Another thing I have observed here are some new faces and some old faces. The good thing about this is that 2 years from now hopefully many of you, if not all of you, will be participating in our next workshop. Those of you who come back will carry a continuity of what went on this year as some of you grey beards here are doing now with what happened at the first workshop 2 years ago.

Now, something was brought to my attention yesterday that I don't know if everybody understood. It was asked just what came out of the first workshop? I was astounded, because I thought that everybody knew that those reports that Jerry Berlin gave the other day were a direct result of our recommendations that were made by our workshop group 2 years ago in Ohio. Towards this end, we pledge to keep you better informed than we did in the past. Those of us who are actively working on these things saw contracts being let and understood that they came from the workshop recommendations; but apparently we didn't make that clear. In addition to that, we will keep a list of all participants here so that as we see other objectives being met that are direct results of your work, your efforts, and your recommendations, you will know about them as quickly as possible and not have to wait 2 years to find out what happened. Again, on behalf of AOPA, thank you all very much for your help.

MR. HARVEY: We are now going to have each of the working group presentations made by each group chairman. There will be formal proceedings available as quickly as we can get them out to each of you. The format for this afternoon: after the group presentations have been made, there will be a question and answer session. The only request is that, for everyone's benefit, the questions be addressed to the speaker from microphones on the side of the auditorium; the first report is from the Aviation Safety Economics Group, the chairman of that is Frank Berardino from Gellman Research Associates.

FRANK BERARDINO, GELLMAN RESEARCH ASSOCIATES: We have three areas to address. They are (1) whether there were any system problems in identifying and undertaking research programs related to safety, (2) whether the available resources in the aviation system are being allocated in a manner which correlates with accident causes, and (3) whether analytic techniques or procedures are available to make proper allocations.

Our meetings focused primarily on one very important topic, and that is information available to both public and private sector decisionmakers which can be used to

allocate resources. The information we focused on primarily was information which correlated payoffs in terms of safety, with the dollars spent on those programs. And we had a demonstration of this by one of the members who had done a study which effectively isolated the risks of undertaking certain flights under certain conditions. We thought that research, at least, pointed the way towards the type of research we'd like to see done in order to make the sort of incremental-type decisions that we think are appropriate for any resource allocation questions.

Our first recommendation is that additional research be done which focuses directly on the dollar payoff undertaking any given action. We believe that this kind of information is useful both in the private and public sector, so that while the FAA can use that information to help allocate its limited resources, the individual pilots can also use the kind of information we are talking about to make decisions on their own actions, to make decisions on purchasing additional equipment for their aircraft. Regarding the latter, we also felt that there was a definite lack of effort on the part of all parties to make this kind of information available to the flying public, and, as a result, their decisions concerning purchasing additional equipment, or their decisions pertaining to taking a flight at any given time, may be biased by not having the correct information. We urge both the FAA and the industry to disseminate that information in a manner which is intelligible to the persons who need it — the pilot and the instructor.

There were other things we did discuss, but no conclusions were reached. I felt that the questions raised were important ones. One question was related to the method by which we try to get people to make the proper decisions in the private sector. In order to get pilots to make correct decisions, the suggestion was made that someone examine the positive instead of the negative reinforcements. For example, insurance reductions by complying with regulations, positive reinforcements perhaps through the use of tax policies. I can relate to you that in other fields and in other countries positive economic reinforcement has been shown to be an effective way to obtain the results desired, which is safety in this case.

The other opinion of the working group, which I thought was very interesting, was the fact that we can fine-tune all the economic models we want and we can work very hard to make sure the data and information are accurate, but in many cases, the social issues which attend any given project swamp the economic ones. Some way has to be found to integrate those social issues into the decisionmaking functions of everyone in both the private and public sectors. Thank you.

MR. HARVEY: The next group is Flight Instruction and that was chaired by Dr. Dick Gilson from Ohio State, Dick?

RICHARD GILSON, OHIO STATE UNIVERSITY: First of all, I'd like to thank some people. The working group was excellent; it was a nice mix of people and I want to thank you all for your help, it was a pleasure working with you. Thanks also to Russ Lawton and Doug Harvey for the opportunity to comment on some very important issues.

There are really two provisos I have in the time span we are allotted. We obviously couldn't address all the subjects that were mentioned or brought up, nor perhaps are we even addressing some of the more important issues to some of you.

Our charge was to come up with recommendations for beneficial changes to pilot training and their implementation procedures. I think, in order to understand our discussions, we have to get a feeling for the tone of the discussions, and the following gives an idea of what took place. Our industry is dependent on oil. We are a conservative industry and we can make, on the basis of that conservative approach, some predictions. Oil will rise in price, unquestionably. The number of flying hours as a result are going to decrease. We are seeing that now. As a result, the amount of time spent in training and proficiency are probably going to decrease. Due to this fact, people will be flying more for business reasons and less for practice. Therefore, a common thread in our discussions was that we should provide some mechanism for more proficiency training, we need to encourage and implement it in some way.

The way the group was organized; we all first voiced our own issues and concerns. We then voted as a group on the priorities of what we wanted to tackle. We took the top four priorities and divided them into subgroups. Those subgroups came up with a number of recommendations and I will articulate on those.

The basic subgroups were these: (1) The first dealt with training media. (2) The second group dealt with certified flight instructor quality control. (3) The third group concerned itself with primary failures of current flight training, and, (4) Finally the Biennial Flight Review was the subject of the last subgroup.

With regard to the first subgroup, the training media group, we described and titled it as simulator and expanded training media utilization.

The objectives to be accomplished were: As an alternative to aircraft experience, establish standards for the accreditation of simulators and other training media, for training, proficiency, and certification of pilots.

The recommendations were as follows:

A — Pilot training should take advantage of the best and most effective training methods available and not be limited to or defined in terms of aircraft hours.

B — Training media should include, but not be limited to, text books, lectures, audio visual materials, examinations, interactive computer assisted instruction, automated evaluation services, training devices, and simulators.

C — Different levels of training effectiveness are achieved through different training media. Training effectiveness should be evaluated and credited on the basis of meeting training objectives and not on the sophistication of this training. As an example, there may be an indication where a picture, a simple picture might provide a greater level of training experience for a particular objective than actually being in the aircraft.

D — Interchange of equivalent training for aircraft hours should be permitted, possibly up to 100 percent, and not limited to current FAR maximums. Provision should be made for credit to exceed, perhaps a ratio of one-to-one for training media, that is, 1 hour of simulator time for ILS training may be equivalent to 3 hours in the aircraft simply because backup modes are available, instant replays are available, and traffic and departures are not there. It may be by event as opposed to time.

E — Standards for evaluating and crediting of training media must be established. The latter was the one that was the most predominant in the group. The standards that must be established for the evaluation and crediting of training media were predominant in discussions, primarily because there was a feeling that the FAA set the standards and the private sector would build toward those standards. That discussion was brought up time and time again.

It was recommended that a committee be established within GAMA/AOPA including industry, FAA, university, and other representatives to review studies and reports on training effectiveness in other subjects and draft standards for crediting simulators and training media and to recommend FAR changes for inclusion in the pilot certification rules of parts 61 and 141. As many of you are aware, there is a proposal coming about to combine parts 61 and 141, and there is a proposed date established that committee recommendations should be made available in time for inclusion in the new FAR's.

The second subgroup dealt with CFI quality control. The objective was to insure that all instructors renewing their certificates are subject to a review of their performance as an instructor. At present, flight instructors may review their certificates through clinics and are not subject to a review of their flight instruction records and performance. The recommendations were as follows:

A — As resources, staffing, and modernization programs permit, a data base should be established that would permit identification of instructors with sub-standard performance.

B — Recommended that the FAA institute a remedial training program as an addition or option to enforcement systems.

To instill or insure a better compliance attitude where an individual has been identified through the enforcement system and to provide a positive motivation in addition to, or in lieu of, disciplinary action. The idea was to provide a positive motivator as opposed to a negative one in the case of suspension. Motor vehicle remedial training programs are conducted in nearly every state of the Union. These have been proven effective and can be applied to aviation.

The third subgroup dealt with some primary failures in our existing training system. The primary problem in our existing private pilot training programs, has to do with the adequacy and ordering of training materials for that private pilot. The intent was to reduce the accident rate for low-time private pilots. There is a high accident rate amongst private pilots particularly in stalls and weather-related areas, as we all know, particularly between the 100 to 300 hour groups.

The recommendation:

A — Charge the FAA with providing an overall higher proficiency for the private pilot certificates, including a greater emphasis on instrument flying.

The final subgroup had to deal with the Biennial Flight Review. There were actually five recommendations here, and I think some familiarization with the Biennial Flight Review procedure as it currently exists, is in order, and I will try to give you that as we go along.

A — The first recommendation dealt with the Biennial Flight Review expiration date. The expiration date should be aligned with other FAA cycles. That is, currently the Biennial Flight Review expires on the day that it was taken. Other expiration dates in the regulations have to do with calendar months. So, the idea here is to align them and make them expire in a calendar month.

There is a reason for the change to calendar months, and the reason is in the second recommendation.

How does one know the Biennial Flight Review is completed today? It is very difficult unless there is an accident or there is a review of pilot training qualifications or log books.

The group recommended that there be a notification to the FAA that the Biennial Flight Review has, in fact, been accomplished. The best way to do that was one that would not incur more paper work, but would use an existing mechanism.

B — The second recommendation is to report the completion of the Biennial Flight Review on the medical application. The objective is that FAA will receive notice of Biennial Flight Review completion on currently existing airmen medical application forms. And there is a legal requirement to sign that, and there is an attestation to the truth of the statements that were made on that. So, therefore, there will be a record as to whether or not that has been completed.

Currently, the problem is that the FAA has no record of the number of Biennial Flight Reviews being completed unless there is an accident or there is a review of a log book. The only change that would be required would be in the medical form to include that particular segment.

C — The third recommendation was to change the Biennial Flight Review to be more concrete in its approach. Currently, as most of you know, the content of Biennial Flight Review is left to the discretion of the person giving the review.

The objective of this recommendation is to have the person being reviewed review subject areas as outlined in the appropriate aeronautical knowledge section for the grade of pilot certificate that he or she currently holds.

D — The fourth recommendation from the group is that the FAA allow the pilot proficiency program that is in effect around the country now to be acceptable as a Biennial Flight Review. Currently, if someone completes the pilot proficiency program, that does not count as a Biennial Flight Review unless the person giving the review says it does. There would be more incentive to the pilot proficiency program if it would also automatically count as a Biennial Flight Review.

E — The final recommendation is that there should be considerations made in terms of aviation insurance premium reductions for flight proficiency. So there would be a monetary incentive for maintaining proficiency. The action to be taken would be that the FAA/AOPA workshop chairpeople would communicate this concept to aviation insurance associations or individual underwriters to determine if discounts can be obtained. And that there would be a report made, hopefully 2 years hence.

There were five areas of concern the group had but just didn't have time to deal with. We would like to have these areas discussed 2 years from now at the next workshop: (1) A fostering of the idea of continued education, either by positive motivation or actually mandating that it should take place. (2) Designated pilot examiner quality control. (3) Flight proficiency and its recognition. Can we encourage it for providing more incentives? (4) What with the energy crisis that exists, people are flying ultra light aircraft, as a way of staying proficient. Currently, there are no regulations covering this area. There should be discussions regarding ultra-light regulations. (5) There should be discussions on the issue of initial training requirements for CFI's. There is a lot of discretion as to what CFI's receive in their initial training. Should there be mandated practice teaching, for example, or should there be grades of CFI certificates?

That is the report of our Committee. Yes, sir?

ROBERT TOSCANI: Did you discuss whether or not instrument training for the rating should begin earlier and that one could get an instrument sooner than 200 hours?

DR. GILSON: We did not, because we felt that the results of the research that's being conducted now are not completely in, and we felt that any discussions would need to be based on those kinds of data. So, we put off that topic.

MR. TOSCANI: What about the EAA proposal for a sports license with less time, was that also considered?

DR. GILSON: It was a part of the overall discussion of ultra-lights. We felt that the more pressing issue would be continued education and proficiency because of the energy problem. We would like this to be considered at the future meeting.

C. O. MILLER: My name is C. O. Miller. In connection with your simulator training, did your working group discuss the most logical place for the simulators to reside? I am assuming you meant the kind that might have motion or at least a visual system associated with them which runs the cost up.

DR. GILSON: First of all, we have to define our terms. We discussed training media, they could be anything from a picture to a movie to a cassette to a desk-top type trainer, to a six-degree-of-freedom training system with a visual system. We felt that to approach the problem from a technological standpoint was to put the cart and horse in the reverse positions. We felt that we should deal with what standards the FAA or industry should come up with, in order to accomplish particular learning objectives. So, I think the feeling was, start out with learning objectives and work backwards and say what is needed, and if the standards are set for the learning objectives, let the private sector build whatever training device is needed in order to accomplish that objective.

MR. HARVEY: Was the recommendation concerning ultra-light regulations with respect to the certification of both the airmen and the vehicles?

DR. GILSON: I think it was because of flight instruction that it covered mostly airmen only. We did not consider the certification of the vehicle itself.

MR. TOSCANI: When you mentioned getting a data base for substandard CFI performance, just how would you go about getting that data?

DR. GILSON: The data are available through current techniques. There are two ways of obtaining it. One way is to examine how many recommendations an individual makes and whether or not these applicants passed or failed the flight test. If they recommend 10 people and 9 fail, you would say that it's probably not the applicant's fault, it most likely is due to the instructor. Another way would be to follow up on their recommendations, the people that actually did get licenses and/or certificates and find out whether or not they have a history of accidents and/or incidents. And then go back and if there is a number of a particular flight instructor's students getting into trouble, then go back and use that. Thank you.

MR. HARVEY: The third group, Pilot Written Exams, was chaired by Russ Watson of Cessna. Russ?

RUSSELL WATSON, CESSNA AIRCRAFT CO.: We did have fun looking at some issues and attempting to determine the recommendations that we are using. The first item was a carryover from 2 years ago. Additional contents should be added in the areas of navigation and meteorology in the commercial pilot written examination. The working group took note of the fact that there was a deficiency in those areas. Presumably commercial pilot applicants had been tested in the private pilot written examination in these areas and already knew all of this information. But there are limitations. First of all, we don't all remember everything forever, and, secondly, there are innovations and some improvements. We have taken note of the fact that the FAA has indeed added these two topics to a forthcoming edition of the commercial pilot written examination. We compliment the FAA for this edition and we hope that perhaps the recommendation of the committee in the First General Aviation Safety Workshop was instrumental in helping to accomplish that.

As a recommendation, we suggest that the fundamental knowledge required of all pilots occur in written examinations for appropriate certificates and ratings, even though it had been tested earlier. We see nothing wrong in reviewing the fundamentals. We see nothing wrong in studying areas where additional knowledge is required in such things as high altitude meteorology, high altitude physiology in sophisticated aircraft systems, and other areas that pertain to advanced ratings.

The recommendation was made that private and CFI written examinations should include specific questions to determine the student's understanding of accident causes. Now, in addition to the fundamentals tested since the 1920's, '30's, and '40's, we become aware of accident trends which reveal causes that need immediate action. We all recall some of these over the past 10 or 12 years. For example, the discovery that wake turbulence is a very serious problem, especially in busy airports with heavier airplanes in front of lighter airplanes, indicating vortex turbulence. So, we do believe that there should be more emphasis on developing test questions which will incorporate known accident causes. It is the consensus of our working group that the causal factors of accidents are not being properly addressed in the written examinations.

Next, we would encourage the U.S. Hang Gliding Association and the Experimental Aircraft Association to confer with the FAA on the subject of ultra-light aircraft in order to gain the FAA's expertise in preparing test questions that could be administered voluntarily. In addition, we would like to see this item placed on the agenda for the next workshop; because by that time ultra-lights may have progressed to the point that we see them as being subject to certification, and certification of their pilots.

Questions on written tests should contain more material relating to judgmental factors. We should be testing the pilot's judgment as well as his knowledge. In the past, written examinations have tested an applicant's academic knowledge and did not attempt to evaluate his or her judgment. A group discussion resulted in a consensus that judgment is very difficult to test objectively the way tests are currently designed. We had some professors and test writers in the group who confirmed that. We do support, however, the research that we heard about yesterday, which dealt with those thought processes whereby an individual acquires good judgment habits. We believe that the results of this research might well be included in the inventory of items on written exams. They unfortunately have to be available in the public domain and in a government document before that can happen, so we would like to take another look at this 2 years from now.

We considered whether a panel of experts should be assembled in order to provide technical information to the FAA Examinations Standards Branch in Oklahoma City. We concluded that this was not necessary because we found that in every area where a test question is written, a conscious determination is made as to whether individuals on the staff have current knowledge in the particular area. If they do not, that individual is sent out into the field or someone from the field is brought in. We acknowledge and encourage that procedure. We would like to look at it 2 years from now and see if we are still happy with the progress being made in that area.

We are very supportive of the program whereby an appropriate individual can be approved as a designated written test examiner, so testing can be done on evenings or on weekends. Those individuals, of course, sign an agreement that they will maintain absolute security over the tests. There have been rumors that there has been some compromising of those security standards. Our committee has no mercy upon anyone that compromises any such standard. We therefore urge the FAA in the strongest possible way to have appropriate investigative personnel determine if indeed there are such things going on and have it stopped.

An individual should expect that the knowledge on which he will be tested is common knowledge and a measurement of whether it is common is whether or not it is available as a public publication. All of this is a reasonable requirement and has resulted in research material being in an abundance of books and pamphlets.

Our recommendation is that the FAA Examination Standards Branch evaluate this concern for the development of a better way to include essential research material in fewer volumes that would be readily available to the flight community. Those are our comments, we'd like to answer some questions.

JOHN KARP: Did your working group discuss, or have any objection to, a flight instructor giving his own unofficial written test in conjunction with BFR?

MR. WATSON: That was not discussed. Let me answer for the committee that we would have no objection to that.

MR. ROBERT EWING: Was any consideration given to getting into the public domain questions that are more relevant to today's flying? For example, flying the HSI related questions could be made available.

MR. WATSON: We discussed this general area in that this knowledge is often in manufacturers' handbooks now. The FAA should have a plan to move it into the public domain as soon as the equipment is sufficiently common to be a fair topic for evaluation.

MR. HARVEY: The next working group dealt with Weather-Related Accidents. That committee was chaired by Dennis Wright from AOPA.

DENNIS WRIGHT, AOPA: Very early in the discussions, we came up with four broad areas of concern that we wanted to address during our deliberations. They were: (1) education, how to better educate people about aviation weather, (2) more accurate observations of the weather phenomenon, (3) dissemination of that weather information, making sure that the information gets to the pilot, and (4) how to insure that the recommendations we were going to make would get acted upon.

The first recommendation was that someone should take on the task of coming up with a structured program for Aviation Weather Education to be used by anybody who deemed it appropriate. The two most often mentioned methods were the FAA accident prevention specialist program and also some of the very active state programs for pilot education.

Then we rapidly moved to the observation of the phenomenon. Our second recommendation is that under the auspices of the Federal Meteorological Coordinator a program for the systematic collection and dissemination of observations to pilots be developed.

The third recommendation was that FAA should reevaluate the current criteria for the implementation of automated weather observation equipment to be bought under the ADAP program in order to provide for the best use of this equipment for general aviation purposes.

Our fourth recommendation was the urging of the continued development of equipment aboard aircraft to provide real-time weather data.

Our fifth recommendation is to expand the present Voice Response System nationwide, as soon as practicable. This is an effort to preclude getting stuck on the phone with a busy signal waiting for a weather briefing.

The sixth recommendation is that the high altitude En Route Flight Advisory Service (EFAS) directly be implemented nationwide.

Our seventh and eighth recommendations are that the National Weather Service look into the feasibility of putting certain elements of aviation weather on the NOAA weather radio system; and that FAA establish a system of high powered non-directional beacons to provide constant coverage of transcribed weather broadcasts.

Our ninth recommendation is to support the expansion of the AM Weather program on the public broadcasting service. Lastly, the group recommends that the FAA Systems Research and Development Service explore the feasibility of providing EFAS traffic presentations to locate aircraft providing and requesting reports.

The group also recommended that AOPA and the FAA workshop chairmen establish an Ad Hoc Committee composed of representatives from industry, government, and the

universities to accept the recommendations of the six workshops, to transmit these recommendations to appropriate officials, and to follow up on a frequent and timely basis. Thank you. Does anybody have any questions?

ROBERT TOSCANI: You said that you would like to have FAA set up beacons to broadcast the transcribed weather reports. Don't the VOR's do that over most of the systems now?

MR. WRIGHT: No, there are some transcribed weather broadcasts on VOR's, but not on all of them. In connection with the NDB, that signal is not line-of-sight, you should always be able to receive the signal.

MR. HARVEY: Our next group examined Aviation Safety Data and that group was chaired by Jack Enders from the Flight Safety Foundation.

JACK ENDERS, FLIGHT SAFETY FOUNDATION: Our working group collectively represented a broad range of experience in accident investigation and safety data analysis. The overall objective that we have in making these findings and recommendations known to you is the improvement of quality and quantity of useful aviation safety data.

I will run briefly through the six items that were recommended 2 years ago and make brief comments on them and then go on to our findings. The first was a need to focus in on more of the human elements and factors surrounding an accident. We endorsed that. We feel that there has been substantial progress in this area.

We would expand the scope of that to include incidents as well as accidents. The second recommendation 2 years ago was that we needed a better way to notify parties of an accident. We did not feel that much had really happened in that area, so, we would endorse that as a continuing need to be aware of. The third was a need for a centralized storage facility and dissemination mechanism for data which would include better rate and exposure tests. The group felt that most of this is well in hand and is in process of being accomplished. Two years ago the need was cited for trend analyses to be made with data from the NASA Aviation Safety Reporting System. It was felt that in the intervening 2 years such use has been made of the NASA data. And the sixth need identified was to publicize the capability of the NASA System. We feel that although NASA is doing a lot of this, the system isn't being utilized by other parties as much as it could.

So with that as a background, let's move into telling you what we came up with this time. What I will relate to you here briefly are two categories of results. Recommendations and findings. When we didn't feel strongly enough about a topic to make a firm recommendation, we left it as a finding which could carry over as a subject for the next workshop.

The first recommendation is that all aircraft accidents should be investigated on site by trained accident investigators. All aircraft accidents now are recorded or documented, but in some cases, due to lack of resources and the extreme variance and severity of the accidents, some of them are essentially desk audited by third party investigators or reporters.

The second recommendation is that all civil aircraft accident investigators should be certified under some formal system approved by the National Transportation Safety Board. This, of course, relates to our first recommendation and has as its

objective the improvement in the quality of accident investigations, so that we can get as much useful data out of an unfortunate situation as we can in the interest of preventing further accidents.

The third item was a finding that none of the data now being collected can be deemed unnecessary. The quality of investigation, however, needs improvement. Especially as regards to the depth of the investigation, the perception of causal factors, human performance information, crashworthiness, and survivability of the accident itself.

The fourth item was a finding. It was felt by the group, that an inexpensive, light weight, flight data recorder or cockpit voice recorder for complex, general aviation aircraft would provide valuable data relating to aircraft accidents.

The fifth item is a finding that there is a need for those who maintain accident data systems to identify and better publicize the availability of their data sources. The background behind this is that we recognize an absence of data surveys which haven't been properly utilized.

The sixth item is a recommendation to establish a central repository of general aviation safety research data and findings to assure that these resources are publicized, current, and easily accessible. This is a companion to the previous finding. You can see that we can pull these things together to make them much more current and available.

The next item is a recommendation to publicize both the existence of and potential uses of the NASA Aviation Safety Reporting System. It seems from recommendations 2 years ago that not enough people know about and are making use of the information in that data base.

The next item is a recommendation emphasizing the existing need for and potential benefits of FAA General Aviation Safety Analysis Workshops. Such workshops should be held for members of the aviation community at least on a semi-annual basis. We have a good example of the worth of that right here. I think aside from the final set of proceedings that come out of this, what certainly must be of more far reaching value, are the communications established among each of us here and the awareness of what the other person is doing.

The last item we had in our panel was a recommendation to determine the feasibility of collecting pilot behavioral data for use in general aviation accident prevention program by following two progressive steps. First, to determine the merit of collecting pilot behavioral data by researching previous use of this data in the commercial and military aviation sectors. If we are successful with the first step, then we should determine what pilot behavioral data can be used as well as show how it can be used to improve general aviation safety. If the answer to either one of those questions is negative, we would drop the effort at least for the time being. That is essentially the result of 2 days of discussion, so if there are any questions, I will be glad to answer them.

MR. TOSCANI: Regarding Flight Data Recorders, how sophisticated and for what level of aircraft sophistication would you suggest them for?

MR. ENDERS: That was a finding where we were not recommending the use of the data recorder; we were suggesting that the kind of data that are available by means of a Flight Data Recorder would be very useful. We are leaving it to future discussions to carry through with how or if this can be done.

MR. JOHN KARP: Did you discuss the new NTSB accident forms which do include the human factors and crashworthiness items.

MR. ENDERS: No, not in detail because that activity is ongoing now and everything is pretty fluid on final format, but the FAA and NTSB are looking at how you make this kind of reporting compatible with existing procedures. Like everybody else, I am waiting anxiously to see how that turns out.

MR. TOSCANI: What level of immunity, if any, do you think should be given to people who make reports through the Aviation Safety Reporting System?

MR. ENDERS: That wasn't really within the purview of our group. We didn't discuss that. Thank you very much.

MR. HARVEY: The last group is General Aviation Aircraft and that group was chaired by John Reed of the FAA Technical Center.

JOHN REED, FAA: I think we had a very good session. We had outstanding representatives from general aviation aircraft and avionics companies as well as outstanding representatives from user groups.

We started out with the question: New technology is providing aircraft and systems designers with the opportunity to augment or supplement aircraft handling qualities. What criteria can be provided which will delineate the degree of allocation assigned to the aircraft, the systems and the crew? And I think the question here really related to that which is behind the instrument panel, the basic systems and the crew interrelationships with the handling qualities of that aircraft. The group was aware of the new technology applications which are being used in certain transport aircraft and recognize the potential for general aviation. This discussion, was centered around technology of active control systems. Technology applications may afford the designer the opportunity to augment aircraft handling qualities for significant performance improvements as well as enhance pilot-crew performance with future complex aircraft. The importance of aircraft handling characteristics as related to specific mission needs, should be considered. That is an important point and I will address this in two areas of this particular subject.

Recommendation 1 — The group would encourage the NASA and FAA activities to continue in the investigation and systematic development of an accident analysis concept which could provide detailed insights into accidents which may be assigned to handling quality problems. That seems like quite a challenge, especially when we look at the accident data that Jack was talking about, how do we glean out of that data or those briefs those possible implications of actual handling quality problems? It is very difficult. The group recommended a review of the existing literature for those research programs that have been accomplished.

Recommendation 2 — NTSB along with interested research parties, should coordinate the accident data reporting to enhance research information needed to explain the why of the accident occurring, not just how it occurred.

The next subject that was addressed was the means by which the number of aircraft accidents attributed to design-induced error can be reduced by modification, design, regulation, and training.

General discussions were conducted about the question from the standpoint of accidents which may be caused by a lack of standardization of items such as gear and flap controls, fuel system, and power plant controls.

We then continued with discussions about some of the possible areas where future design problems may exist. One of the interesting aspects of cathode ray tube multi-function cockpit displays which were discussed was that the crew interface in the cockpit environment should be carefully considered in the design, development, and introduction of those particular systems.

We next discussed what potential problems may exist in the certification of aircraft digital flight controls and avionic systems. The feeling was that we are just getting there in general aviation, we haven't had enough experience yet with those problems both from the design and operational standpoints and their use of maintenance aspects.

The working group recognized the accelerated development and implementation of advanced digital flight controls and avionic systems in current and new generation aircraft. This rapid introduction is creating certification, installation, operation, and maintenance concerns. The FAA needs to become more knowledgeable about the hardware and software aspects in order to certify them in a timely and safe manner. We have a recommendation that NASA, FAA, and industry should jointly coordinate the new technology applications and operations and communicate development programs to each other.

Federal Aviation Regulation (FAR) Part 23 requirements lead to varying degrees of interpretation or misinterpretation by industry and the FAA. Are there any specific key requirements which should be changed? The people at NASA Langley are working on advanced aircraft designs that relate to single-engine, high-performance aircraft. Well, one of the problems in doing this particular research runs right up against a FAR 23 limitation. There is one portion of the regulations that may inhibit the development of a high-performance, fuel-efficient aircraft. That particular requirement is the one relative to the 61-knot stall speed.

Therefore, the working group supported and encouraged the philosophy that the FAR's should be written with new technology implications in mind and that those current FAR's are guidance material which appear to impact innovative designs.

In this regard, the group supports the NASA research for single-engine, high-performance, fuel-efficient, general aviation aircraft realizing FAR 23 regulation of single-engine stall speed at 61 knots is a limitation to improved performance.

The group recommended that a stall/spin workshop be created in the FAA general aviation lead region, which would be co-sponsored by industry, to explore and study critical safety issues such as the assessment of the spin recovery requirement and the above 61-knot stall/speed requirement and other related aircraft stall/spin issues, also, that NASA be encouraged to continue their stall/spin research and provide industry with the data as rapidly as they can. Thank you.

MR. HARVEY: This then is the product of a day and a half of a lot of dedicated people.

Someone mentioned earlier the establishment of an Ad Hoc working group. I think, at this time, it may be appropriate to announce that we are in the planning stages of the Third General Aviation Safety Workshop in cooperation with Embry-Riddle Aeronautical University. The workshop will be sponsored by Embry-Riddle and the Technical Center. The success of this workshop will come about in terms of what is reported 2 years from now down in Florida.

When you get the proceedings of this workshop, if you view them as a static document, as something to be read and then filed away, we will have failed in our purpose of having you come to this event. You should review the document, as we will here at the Technical Center, as a working document for planning purposes.

On behalf of the FAA Technical Center and Aircraft Owners and Pilots Association, I thank you all for your time and efforts, and especially the working group chairmen for their task of bringing together such diverse backgrounds in a day and a half.

I thank you all again and we will see you in 2 years.

SUMMARY OF RECOMMENDATIONS FROM THE  
SECOND GENERAL AVIATION SAFETY WORKSHOP

I. AVIATION SAFETY ECONOMICS.

1. Additional research to be done which focuses directly on the dollar pay-off underlying any given action regarding safety.

2. Both the FAA and industry need to disseminate cost/benefit information in a manner that is intelligible to the persons who need it — the pilot, the instructor, etc.

3. Develop a systematic way to integrate social issues into the decision-making process of everyone — public and private sectors alike.

II. FLIGHT INSTRUCTION.

4. Establish standards for the accreditation of simulators as well as training materials for training, proficiency, checking and certification/recertification of pilots and not to be limited to or defined in terms of aircraft hours.

5. Require that CFI's who renew their certifications be subject to review of their performance as an instructor (this to be accomplished at the GADO level).

6. Use of remedial training by FAA in cases of pilot certificate suspensions and penalties, and in cases of the "deferred suspension" sanction.

7. Require an overall higher proficiency for the private certificate; including greater proficiency, with emphasis in instrument flying. As feasible, expose each trainee to actual or simulated weather.

8. Align the BFR date or expiration with other FAA cycles, such as calendar months.

9. Report completion of BFR on medical application.

10. BFR is too vague and discretionary; therefore, require a review of subject areas of appropriate aeronautical knowledge for each level of certificate held.

11. Allow completion of FAA's Pilot Proficiency Award Program to serve as meeting requirements for the BFR.

12. Work out a methodology to have the insurance companies recognize completion of the FAA's Pilot Proficiency Award Program by offering some form of financial incentive.

### III. PILOT WRITTEN EXAMINATIONS.

13. Additional material to be added in the area of navigation and meteorology to the commercial pilot written examination.

14. Private or CFI written examinations should include specific questions to determine the student's understanding of the causes of accidents. There should be more emphasis on developing test questions which will incorporate known accident causes.

15. FAA should develop a written exam for operators of ultra-light aircraft to be administered by industry associations or by the FAA.

16. Regards the theoretical versus the practical questions on tests: develop and use practical test questions in lieu of purely academic or theoretical questions is highly desirable.

17. Questions on written tests should contain more judgmental factors.

18. Sectionalization of the written exam is desirable.

19. A panel of experts should be assembled to provide technical information to the FAA Test Writing Branch (the Examinations Standards Branch in Oklahoma City).

20. Appropriate individuals from organizations such as colleges and universities should be approved as "designated written test examiners" so testing can be done on evenings or weekends.

21. Written examinations should be established as part of the Biennial Flight Review process.

22. The Examination Standards Branch of FAA should determine a better way to include "essential material" as reference material for the written exams in fewer volumes.

### IV. WEATHER-RELATED ACCIDENTS.

23. Some organizations should take on the task of coming up with a structured program for aviation weather education to be used by anyone who deemed it appropriate to pursue.

24. Under the auspices of the Federal Meteorological Coordinator, a program for the systematic collection and dissemination of PIREPS to pilots be developed.

25. FAA should reevaluate the current criteria for the implementation of automated weather observation equipment to be purchased under the ADAP program; this to provide for the use of this equipment at more general aviation airports.

26. Initiate programs for the continued development of equipment aboard aircraft to provide real-time weather data, (includes in-flight T.V. relay, onboard weather radar, and data up-link systems).

27. Expand the present Voice Response System (VRS) nationwide as soon as practicable.

28. High altitudes EFAS discrete frequencies be implemented nationwide.

29. The National Weather Service should investigate the feasibility of putting certain aviation information on the NOAA weather radio network system.

30. FAA should investigate establishing a system of high powered, non-directional beacons to provide constant coverage of transcribed weather broadcasters.

31. Help foster the expansion of the AM Weather program on the public broadcasting service, plus a method to help traveling pilots know what station and when this program is aired in specific locations.

32. The FAA Research and Development Group should explore the feasibility of providing EFAS positions with traffic presentations to help them in locating aircraft and in providing and requesting pilot reports.

33. An ad hoc committee composed of representatives from industry/government and the user groups to transmit the recommendations from this workshop to appropriate officials and to follow-up on a frequent and timely basis.

#### V. AVIATION SAFETY DATA.

34. Need to focus on more of the human elements and factors surrounding an accident. (Expand the scope of aircraft accident investigations to include incidents as well as accidents.)

35. Need a better way to notify parties of an accident.

36. Need for a centralized storage and dissemination of accident data, including a better quality of rate and other data alternatives to accidents per passenger mile. Improved data classification and standardization of terms and definitions (Note: Most of this is "well in hand" and is in process of being completed).

37. Publicize the capability of NASA's Safety Reporting System in the sense that trend analysis could be made of this data, and although NASA is doing a lot of this, it is not being utilized by other parties as much as it could.

38. All aircraft accidents should be investigated on site by trained accident investigators.

39. All civil aircraft accident investigators should be certified under a formal system approved by the National Transportation Safety Board.

40. None of the data now being collected during the course of an accident investigation should be deemed unnecessary, but the quality of investigation needs improvement, especially as regards the depth of the investigation, the perception of identifying causative factors, human performance, crashworthiness, and survivability of the accident itself.

41. Inexpensive lightweight FDR or CVR for complex general aviation aircraft is needed to provide recording of valuable data relating to aircraft accidents.

42. There is a need for those who have data to identify and better publicize the availability of their existing (and nonexistent) accident data base sources, such as insurance companies, workman's compensation boards, etc.

43. There is a need to establish a central repository of general aviation safety and safety research data and findings, and to assure that these resources are publicized, are current, and are easily accessible.

44. Publicize both the existence of, and potential uses of, NASA's Safety Reporting System. Not enough people know about or are making use of the information in this data base.

45. Emphasizing the need for, and potential benefits of, FAA's General Aviation Safety Analysis Workshops. These should be made available to the aviation staff community at least on a semiannual basis.

46. Explore the need for, and means of, data communication of third party trends and experience data to regulatory and research activities, manufacturers, as well as trade associations and professional groups.

47. Determine the feasibility of collecting pilot behavioral data for use in general aviation accident prevention by following two progressive steps — determine the merits of collecting pilot behavioral data by researching the previous use of this data in the commercial and military aviation sectors — determine what pilot behavioral data can be used, as well as to show how it can be used to improve general aviation safety.

#### VI. GENERAL AVIATION AIRCRAFT.

48. Encourage NASA and FAA R&D activities in this area to continue.

49. Investigate and systematically develop an "accident concept" which could provide detailed insight into accidents which may be assigned to handling quality problems.

50. DOD and industry should coordinate their accident safety data reporting efforts to enhance research information needed, to explain the why of the accident occurring — not just when it occurred.

51. NASA, FAA, and industry should jointly coordinate new technology applications and operations and to communicate design, development, operational and maintenance programs with each other.

52. FAR's should be written (and old ones rewritten) with new technology implications in mind, including a review of those current FAR's which appear to impact innovative design.

53. Fuel-efficient general aviation aircraft designs are restricted because the engine stall speed of 61 knots (as a limitation). To improve efficiency and performance, NASA should be encouraged to continue their R&D activities in this area. If results warrant, FAA should amend Part 23 to relax this restriction.

54. A specific stall-spin workshop be held by the FAA general aviation lead region (which would be cosponsored by industry to explore and study critical spin-safety issues such as assessment of the spin recovery requirement, the stall speed requirement of 61 knots, and other related aircraft stall/spin issues.

55. NASA should be encouraged to continue their stall/spin research and to provide industry with the data as rapidly as they can.

APPENDIX  
LIST OF ATTENDEES

Workshop I  
Aviation Safety Economics

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Workshop II  
Flight Instruction

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